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VOLUME II OF II

CATEGORY II PERFORMANCE TEST OF THE UH-1N HELICOPTER

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TECHNICAL REPORT No. 72-17

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AIR FORCE FLIGHT TEST CENTER
EDWARDS AIR FORCE BASE, CALIFORNIA
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE

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TEST TECHNIQUES, DATA ANLYSIS METHODS, AND TEST DATA

General

Dimensional analysis of the major items affecting helicopter performance yielded the variables used to present performance data. These dimensionless variables are defined as follows:

$$C_p = \frac{\text{shp} \times 550}{\rho A\ (\Omega R)^3} = K_1 \left[\frac{\text{shp}}{\delta_a \sqrt{\theta_a}}\right] \left[\frac{1}{N_R/\sqrt{\theta_a}}\right]^3$$

$$C_T = \frac{W}{\rho A\ (\Omega R)^2} = K_2 \left[\frac{W}{\delta_a}\right] \left[\frac{1}{N_R/\sqrt{\theta_a}}\right]^2$$

$$M_{TIP} = \frac{V_t + 0.592\ (\Omega R)}{38.967\ \sqrt{T_a}} = K_3 \left[\frac{N_R}{\sqrt{\theta_a}}\right] \quad (1 + \mu)$$

$$\mu = \frac{V_t}{\Omega R} = K_4 \left[\frac{1}{N_R/\sqrt{\theta_a}}\right] \left[\frac{V_c}{\sqrt{\delta_a}}\right]$$

Notes:

(1) Constants K_1 through K_4 pertain to specific rotor systems and are: $K_1 = 64138149/(R)^5$, $K_2 = 12211.87223/(R)^4$, $K_3 = 0.00009373/(R)$. For the UH-1N they are: $K_1 = 8.0549$, $K_2 = 0.0368$, $K_3 = 0.0022495$, $K_4 = 0.6719927$ (for V_c in knots).

(2) For the test conditions encountered, it was assumed that $V_t \sqrt{\sigma} = V_c$, i.e., $\Delta V_c = 0$. ΔV_c = compressibility correction to calibrated airspeed.

Pitot-Static System Calibration

Airspeed calibration tests were conducted to determine the position error of the standard and test (boom) airspeed systems. The tower fly-by and ground-speed course were the methods used. These techniques provided level flight airspeed calibrations, and also provided a static source calibration for the standard and test altimeter position errors for level flight.

The standard system was calibrated against the test boom system in climb and autorotation, the results of which are presented in figure 2, appendix I.

The test boom system had a full-swiveling pitot-static source which remained aligned with the airstream within large angles of fuselage attitude relative to the airstream.

The standard pitot-static system was also calibrated in level flight for the two UH-1N helicopters used in Category II systems and all-weather tests. The ground-speed course technique was utilized on both aircraft. The results of these tests are incorporated in the airspeed and altimeter calibration plots presented in figures 1 and 3, appendix I.

Hover

In-ground effect and out-of-ground effect tethered hovering performance data were obtained at skid heights of 2, 4, 10, 15, 25, 35, and 60 feet. Constant referred rotor speeds ($N_R/\sqrt{\theta_a}$) were flown in order to determine compressibility effects on power required. Referred rotor speeds of 300, 310, 320, and 330 rpm were flown. With this technique, the rotor speed was varied with temperature to maintain a constant $N_R/\sqrt{\theta_a}$ which resulted in a constant Mach number at the rotor blade tip. Free hover data were obtained at 100 feet skid height to verify that the aircraft was actually out of ground effect at a skid height of 60 feet. All hover tests were conducted in less than 3 knots of wind.

Table I, appendix I, lists the conditions in which the hovering data were obtained.

During the tethered hovering tests the helicopter was tethered to the ground by a cable and load cell (which measured cable tension). Thrust produced was assumed equal to the gross weight of the helicopter, cable and load cell plus the cable tension.

Power coefficient (C_P) was plotted against thrust coefficient (C_T) for each skid height; fairings defined by points of equal referred rotor speed ($N_R/\sqrt{\theta_a}$) were established. The hover data are presented in figures 4 through 13, appendix I.

Hover summaries were derived for specified altitude and temperature conditions at maximum power available utilizing the nondimensional hover plots and are presented in figures 5 and 6.

Table I

SUMMARY OF HOVER TEST CONDITIONS

Skid Height (ft)	$N_R/\sqrt{\theta_a}$ = 300 rpm		$N_R/\sqrt{\theta_a}$ = 310 rpm		$N_R/\sqrt{\theta_a}$ = 320 rpm		$N_R/\sqrt{\theta_a}$ = 330 rpm	
	Pressure Altitude (ft)	FAT (deg C)	Pressure Altitude (ft)	FAT (deg C)	Pressure Altitude (ft)	FAT (deg C)	Pressure Altitude (ft)	FAT (deg C)
2	9,560	9	2,130 9,560	-7 8	1,990 9,560	-1 8	1,970 2,110 10,170	-1 -4 -6
4	9,570	9	2,720 9,590	-7 8	2,170 9,590	0 7	2,160 2,110 10,230	0 -4 -7
10	9,640	10	1,990 9,640	-4 9	1,930 9,640	-5 9	1,930 2,080 10,270	-5 -6 -7
15	- - -		2,060 9,850	0 0	2,030 9,850	-2 -1	2,030 2,110 9,670 9,840	-2 -4 3 -1
25	9,640	7	2,170 9,600	1 6	2,170 9,620	1 5	2,170 2,080 9,850	1 5 -2
35	- - -		2,190 9,860	2 -1	2,190 9,820	2 -1	2,180 2,080 9,820	0 -5 -3
60	- - -		2,050 9,640	-2 -0	2,060 9,650	-2 0	2,060 2,100 9,650	-2 -5 0
100	4,090 9,700	2 -2	4,100 9,700	1 -2	4,100 9,690	1 -2	4,100 9,690	1 -2

Note: All above conditions are average values.

Takeoff

General

Takeoff tests were conducted at an average pressure altitude of 9,700 feet. Gross weight was varied from approximately 9,000 to 10,500 pounds. Initial rotor speed was 324 rpm (100 pct), and all takeoffs were made with a mid (sta 137.0) cg loading. Maximum available power was used for all takeoffs. For airspeeds below 25 KIAS, a pace vehicle was used as a reference to obtain the desired airspeed.

Power, weight and atmospheric conditions were recorded for each takeoff. A Fairchild Flight Analyzer was used to record a time history of each takeoff. Ground speed and horizontal and vertical distances were derived from the time histories. The test results are presented in figures 18 through 37, appendix I.

The ΔC_p parameter was used to correlate the takeoffs. The excess power available (ΔC_p) was defined as the difference between the maximum power available recorded at the 50 foot height and the power required to

hover at a referenced skid height (4 feet and 15 feet). This definition may be expressed in the nondimensional power coefficient term as $\Delta C_P = C_{P_{Available}} - C_{P_{Required\ to\ hover}}$. Gross weight was varied to obtain a wide range of ΔC_P values. For each ΔC_P, a plot of distance to a 50-foot height versus true climbout airspeed was constructed. A carpet plot using ΔC_P for correlation was then constructed showing distance required for various climbout airspeeds in terms of the excess power available.

The following takeoff techniques were investigated to determine the takeoff performance of the UH-1N:

1. Level acceleration from a 4-foot hover with and without rotor rpm bleed.

2. Level acceleration from a 15-foot hover.

3. Climb and acceleration from light-on-skids with and without rotor rpm bleed.

Takeoff Techniques

The level acceleration (no rotor rpm bleed) technique was performed as follows:

The helicopter was stabilized at the desired hover height with rotor rpm (N_R) set at 100 percent (324 rpm). The helicopter was then transitioned into forward flight as smoothly and rapidly as possible with use of cyclic and collective pitch. Collective pitch was increased to the maximum possible without drooping the rotor below 100-percent rpm. The power turbine governor (beep) switch was increased to maximum during the transition, and N_R was controlled with collective pitch. The helicopter was transitioned into forward flight at a constant skid height until the desired takeoff speed was reached. As the takeoff speed was reached, the pitch attitude of the helicopter was adjusted to maintain the desired airspeed until above the desired 50-foot altitude. This technique also applied to level acceleration takeoff from a 15-foot hover, simulating a sling load.

The level acceleration (with rotor bleed) technique was basically the same as the "no bleed" technique with the exception of the N_R control. In the "bleed" technique, the N_R was slowly bled off in the climb so as to droop from 100 percent in the level acceleration to 97 percent (314 rpm) upon reaching 50 feet of altitude.

The climb and acceleration technique was performed as follows:

Beginning from a light-on-the-skids condition, power was increased to maximum as the aircraft left the ground; desired airspeed was obtained by holding pitch attitude. For these tests the pitch attitude was set at 3 degrees noseup on the ground. The maximum pitch attitude used was 10 degrees nosedown at a climbout airspeed of 45 knots. At 2 degrees nosedown, a climbout airspeed of 25 knots was achieved. During the climb the rotor rpm was held constant at 100 percent. Upon reaching 50 feet, the airspeed was allowed to increase while maintaining altitude. The climb and accelerate technique was also repeated using the N_R "bleed" technique. In this technique the N_R was "bled" at approximately 2 rpm

per second from 100 percent at 15 feet to 97 percent at 50 feet. Upon reaching 50 feet, the collective pitch was reduced very slightly to allow N_R to increase while maintaining altitude.

Climb

Sawtooth climbs were conducted at pressure altitudes of 5,000, 10,000, and 14,000 feet at gross weights of approximately 8,500 and 10,000 pounds and at maximum continuous power (88-percent torque).

The observed rates of climb were corrected to test day tapeline rate of climb using the following equation:

$$R/C_t = \frac{dh}{dt} \times \frac{T_{a_t}}{T_{a_s}}$$

where

R/C_t = rate of climb (tapeline), feet per minute

$\frac{dh}{dt}$ = slope of the pressure altitude versus time curve, feet per minute

T_{a_t} = test day ambient temperature, degrees K

T_{a_s} = standard day temperature for the test attitude, degrees K

The test day values of the rates of climb for the altitudes and temperatures tested are presented in figures 38 and 39, appendix I. A summary of the climb performance is presented in table II.

Two continuous climbs were conducted from a 2,000-foot pressure altitude to the service ceiling or envelope limit using a mid cg location, maximum continuous power, 314-rpm rotor speed, and climb-start gross weights of 8,790 and 10,400 pounds. Only one climb was made at each gross weight. The climb tests were conducted at 53 KIAS on the nose-boom airspeed system. This speed was determined from the minimum power required from the level flight speed-power tests.

The observed rates of climb were corrected to test day tapeline rates of climb as discussed for the sawtooth climbs.

The test day values for the rate of climb are presented along with shaft horsepower required, calibrated airspeed, true airspeed, gross weight, fuel used, time to climb, nautical air miles traveled, ambient air temperatures, and pressure altitude. Results of the continuous climb tests for test day conditions are presented in figures 40 and 41, appendix I.

Table II

SUMMARY OF LEVEL FLIGHT TEST CONDITIONS

UH-1N USAF S/N 68-10776

T400-CP-400 Engine

Category II

Cond No.	$C_T \times 10^4$	Avg $N_R/\sqrt{\theta_a}$ (rpm)	Avg Gross Weight (lb)	Avg Pressure Altitude (ft)	Avg FAT (deg C)	Avg N_R (rpm)	Remarks
1	28	340	7,800	3,250	-25	315	
1	28	340	7,900	2,980	-12	323	Single engine
2	32	319	7,940	3,090	4	313	
2	32	319	7,960	3,270	4	313	
2A	32	300	7,580	940	21	303	
2B	32	310	7,970	1,370	20	313	
3	32	331	8,430	3,420	-7	319	
3	32	329	8,380	3,420	-15	312	Single engine
3	32	330	8,660	2,410	-9	316	Single engine
4	32	333	8,510	3,260	0	324	
5	32	338	8,430	4,470	-7	311	
6	32	339	8,150	5,760	-26	314	
7	32	341	8,560	4,500	-23	315	
8	36	300	8,600	710	24	305	
9	36	310	9,120	970	24	314	
10	36	321	8,180	5,510	0	312	
10A	36	319	8,520	4,420	16	320	
10	36	320	8,460	4,650	2	313	Heat on
10	36	320	8,580	4,350	9	316	Fwd cg
10	36	323	8,520	4,490	5	317	Aft cg
11	36	323	8,090	7,900	-3	321	
12	36	341	7,840	10,070	-20	319	
12	36	340	8,030	9,790	-18	320	Single engine
13	40	301	9,230	1,650	23	305	
14	40	310	8,750	4,860	15	310	
14	40	310	9,250	3,300	26	316	Full armament
15	40	320	8,510	7,260	0	312	
16	40	329	8,080	10,260	2	321	
16	40	330	8,430	9,150	-14	313	Single engine
17	40	339	9,870	6,620	-24	316	
19	43	301	9,900	1,760	24	305	
20	43	311	9,180	5,460	18	312	
20	43	310	8,700	6,950	17	310	Rockets only
20	43	310	9,480	4,130	25	316	Full armament
21	43	320	8,920	7,890	7	316	
22	43	331	8,610	10,860	-3	321	
22	43	332	8,930	9,580	-3	322	

Table II (Concluded)

Cond No.	$C_T \times 10^4$	Avg $N_R/\sqrt{\theta_a}$ (rpm)	Avg Gross Weight (lb)	Avg Pressure Altitude (ft)	Avg FAT (deg C)	Avg N_R (rpm)	Remarks
23	43	340	9,590	9,320	-27	314	
25	43	301	9,820	3,780	16	302	
26	46	310	9,030	7,700	16	310	Rockets only
26	46	311	9,430	6,420	13	310	Full armament
27	46	320	8,880	9,790	-2	311	
29	46	339	8,390	14,340	-30	311	
31	50	300	9,870	5,850	18	302	
32	50	311	9,450	8,570	14	310	
32	50	311	9,480	8,600	13	310	Full armament
33	50	319	9,060	11,290	8	316	
34	50	330	8,870	13,390	-7	318	
35	50	340	8,440	16,330	-32	311	
44	53	300	9,540	8,240	16	301	

Level Flight

Level flight performance tests were conducted to determine power required, range, fuel flow, compressibility effects, and engine characteristics. The tests were conducted at pressure altitudes from 710 to 16,330 feet, ambient air temperatures from +26 to -32 degrees C, and at average gross weights from 7,580 to 9,870 pounds. Each flight was conducted at a predetermined and constant thrust coefficient (C_T) and referred rotor speed ($N_R/\sqrt{\theta_a}$) by maintaining a constant W/δ_a relationship. This required increasing the pressure altitude as fuel was consumed and adjusting the rotor speed as the ambient air temperature varied so that W/δ_a and $N_R/\sqrt{\theta_a}$ remained constant. The data were corrected for adiabatic temperature rise created by the aircraft's forward velocity.

Level flight performance was obtained in the clean loading (twin- and single-engine), with full external armament (cargo doors open, two 7.62mm miniguns extended fixed to fire forward, and two LAU-59/A rocket launchers installed), with 2 LAU-59/A rocket launchers only, and with forward and aft cg locations. The test conditions flown are shown in table II, appendix I.

The level flight data were reduced to nondimensional form and plotted as C_P versus C_T for constant μ and for lines of constant $N_R/\sqrt{\theta_a}$. These are presented in figures 42 through 51, appendix I. The individual level flight plots are presented in figures 52 through 101, appendix I.

Level flight performance summary curves of loiter (minimum power required) fuel flow and V_c and long range cruise NAMPP and V_t were obtained by entering the nondimensional level flight plots (figures 52 through 101, appendix I, at a given set of flight conditions and obtaining the corresponding nondimensional power coefficient. Fuel flow was found by referring to sea level standard day conditions the shaft horsepower obtained from the nondimensional power coefficient and entering the engine characteristics plots. The referred fuel flow ($W_f/\delta_{t_2}\sqrt{\theta_{t_2}}$) was then corrected to the desired atmospheric conditions.

Specific range was calculated using:

$$NAMPP = \frac{V_t}{W_f}$$

Vibration

Vibrations were recorded on an oscillograph, measuring both the lateral and vertical vibrations at the pilot's seat (sta 46.7) and the cargo area (sta 133). A calibration curve of single amplitude per g versus frequency was obtained. This curve was fitted by a fifth order polynomial equation. The vibration traces were divided into ten equal time segments per cycle and the amplitudes were measured. These points were fitted by a Fourier analysis. The frequency was calculated from the time of the cycle and the amplitude was calculated from the Fourier analysis. Knowing these two values and by going into the calibration curve, the g forces were obtained. These calculations were done on the IBM 1620 computer. The vibration data are presented in figures 102 through 111, appendix I.

Autorotational Descents

Autorotational descents were made to determine the airspeeds for minimum rate of descent and maximum glide range at various rotor speeds. Sawtooth descents were flown at 8,500- and 10,000-pound gross weights at 5,000 and 10,000 feet PA. Rotor speeds of 294 rpm (91 percent), 324 rpm (100 percent) and 339 rpm (104.5 percent) were investigated.

The observed rates of descent were corrected to test day tapeline rate of descent using the following equation:

$$R/D_t = \frac{dh}{dt} \times \frac{T_{a_t}}{T_{a_s}}$$

R/D_t = rate of descent (tapeline), feet per minute

$\frac{dh}{dt}$ = slope of the pressure altitude versus time curve, feet per minute

T_{a_t} = test day ambient temperature, degrees K

T_{a_s} = standard day temperature for the test altitude, degrees K

The test day values of the rates of descent are presented in figures 114 through 117, appendix I.

The airspeed for the maximum glide range was found at the point of tangency of a line drawn from the zero R/D and V_t intersection to the R/D versus V_t fairing.

Slope Landing

Slope landing tests were made to determine the maximum slope angles on which the UH-1N could be landed, and to develop the pilot techniques involved. Aircraft gross weights and cg locations tested were:

Gross Weight (lb)	Longitudinal cg Location (sta)	Lateral cg Location (in.)
8,500	137 (mid)	0
10,000	137 (mid)	0
10,000	141 (aft)	0
10,000	133 (fwd)	0
10,000	134 (fwd)	5.2 right

Before starting the actual slope landings, the clearance between the main rotor blades and the fuselage (including the special instrumentation test boom) was investigated. Fore and aft cyclic control inputs were made from the neutral position to full travel in increasing increments of 1 inch. Collective control inputs to full down were made from displacements up to 4.14 inches (equivalent to approximately 55-percent torque) from full down. Simultaneous fore and aft cyclic and collective inputs were made incrementally up to full cyclic travel (from neutral) and from 4.14 inches from full down collective. Main rotor blade clearance from the forward fuselage, special instrumentation noseboom, and the tailboom was observed visually. At no time did the rotor blades come closer than 10 to 12 inches from the tailboom or 15 to 20 inches from the noseboom. Blade overshoot with collective input appeared to be undetectable or negligible due to the relatively high rigidity of the rotor system.

The actual slope landing tests were performed on a hill with a large variety of slope angles up to approximately 17 degrees. The surface was typical of a type found in this desert region - decomposed granite and irregular quartz rock ranging in size from very fine gravel to rocks up to 3 inches in diameter. The helicopter landing skids made slight, if any, imprint on the surface. This surface was relatively slippery at the higher slope angles and required care when landing the aircraft.

The slope landings were made while oriented nose up-slope, nose down-slope, and cross-slope right and left. For the landing, the helicopter was first hovered just off the ground (1 to 2 feet) and allowed to stabilize. The collective was slowly lowered until the skid(s) contacted the ground. Cyclic control was applied in the up-slope direction to firmly plant the skid(s) on the slope. The collective was slowly lowered and, as the aircraft rotated, the cyclic control was applied in the up-slope direction to keep the skid in place. Once the helicopter had both skids on the slope, the collective was fully lowered and the cyclic stick was centered. The primary slope angle limiting factors were cyclic control stop limits, fuselage nose clearance and tail skid clearance. At each of the maximum slope angles tested, the cyclic control stops were reached.

Takeoff from the slope was accomplished by slowly increasing the collective until the helicopter was slightly light on the skids while holding the cyclic stick toward the up-slope. As the aircraft came off the slope the cyclic stick was centered to hold the helicopter level.

The results of the slope landing tests are shown in figure 118, appendix I.

Height-Velocity

General

Height-velocity performance tests were conducted to define the single-engine go-around and landing envelopes following a simulated single-engine failure. Tests were conducted at gross weights from 7,700 to 10,500 pounds and pressure altitudes from 2,100 to 9,600 feet.

Surface winds were 3 knots or less during these tests. A constant aircraft gross weight was maintained by reballasting as fuel was consumed. Power, weight, and atmospheric conditions were recorded for each point. A Fairchild Flight Analyzer was used to record a time history of each approach. Ground speed and horizontal and vertical distances were derived from the time histories.

A power ratio was determined for each test condition. This power ratio was defined as:

$$\frac{\text{Single-engine maximum power available}}{\text{Power required to hover OGE}}$$

These powers were the test average single-engine maximum power available and the test power required to hover OGE.

The results of the height-velocity tests are presented in figures 119 through 126, appendix I.

Technique

All height-velocity points were entered from stable, unaccelerated flight conditions. Single-engine failure was simulated by rapidly retarding the No. 2 engine to flight idle. Collective pitch control movement was delayed for 2 seconds after the throttle cut to simulate pilot reaction time. Rotor rpm (N_R) prior to cut was 100 percent. After the delay period, the collective pitch was lowered to restore the N_R to 97 percent, and the power turbine governor (beep) trim switch was increased to maximum. The power on the operating engine was kept at maximum during the landing or go-around by maintaining 97-percent N_R.

Prior to each test condition the minimum OGE single-engine level flight speed and the minimum climb speed were determined. These speeds were used as the target speeds for each data point. These speeds changed (lowered) as ground effect built up, but the out-of-ground-effect speeds were used to maintain consistency of data.

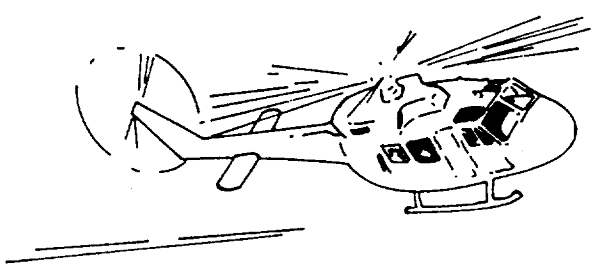
Tests were also conducted to determine the pitch attitude change required from the hover condition to achieve the target speeds. A pitch

change of approximately 20 degrees nosedown gave the best compromise between pilot task and aircraft response. This was used throughout the tests.

The tests were initiated at each test condition from the high hover condition (when OGE hover was possible). Each succeeding point was at a lower altitude until a landing was required. At that point the landing was repeated to obtain a lower touchdown speed. Each succeeding point on the curve was obtained by lowering the entry speed at each altitude until a landing was again required. The lower hover points were determined by increasing hover heights in small increments until the sink rate after engine cut indicated a harder than normal landing would occur.

From the hover conditions above 100 feet, the pitch attitude change decreased progressively as the height above the ground decreased. Below 20 feet at 5,000 feet H_p the collective pitch was not lowered to regain lost rpm to minimize a buildup of the rate of descent. At the 9,600-foot H_p point this lower altitude restriction was 30 feet.

Two landing techniques were used during these tests. The first was to minimize the flare. This was the direct result of attempting to make a go-around. When it was determined that a landing was necessary, the aircraft was flared to approximately 10 degrees noseup to reduce airspeed. Prior to touchdown the aircraft was leveled and at the same time the collective pitch control was raised to cushion the landing. This technique resulted in relatively fast but gentle touchdown speeds. The second technique was to flare the aircraft more steeply, 10 to 20 degrees noseup, to slow the touchdown speed. Collective pitch was used slightly in the flare to keep the rotor rpm from increasing excessively. An excessive N_R increase at this point would have resulted in sensing of an overspeed in the operating engines, thus reducing power which would not have been regained before touchdown. The aircraft was leveled before touchdown and collective pitch was increased to cushion the landing. This technique resulted in significantly slower touchdown speeds.



Power Determination

The combining gearbox has a hydromechanical torquemeter for each engine installed as an integral part of the combining gearbox. The operation of the torquemeter is based on the principle that a torque applied to a helical gear produces an axial force normal to its plane of rotation. Torque is measured as the difference between oil pressures in the torquemeter and in the gearbox.

Shaft horsepower was determined from inflight torquemeter readings and rotor rpm using the following equation:

$$shp = \frac{2\pi}{33,000} \times N_E \times Q$$

where

shp = engine output shaft horsepower

N_E = gearbox output shaft rotational speed, rpm

Q = output shaft torque, ft-lb

Gearbox output shaft speed was determined from rotor speed as follows:

$$N_E = N_R \times 20.37$$

where 20.37:1 is the main transmission gear ratio.

Substituting the last two equations, an equation for calculating shaft horsepower was developed:

$$shp = \frac{2\pi \times N_R \times 20.37 \times Q}{33,000} = 0.0038784 \times N_R \times Q$$

The T400-CP-400 power package as installed in the UH-1N produced a slight complication in computing shaft horsepower. Separate torquemeters are provided for each engine, however, there is only one output shaft. Therefore, when the engine was calibrated the dynamometer attached to the single output shaft read total torque for the package. The torquemeter calibration presented the sum of the two torquemeter readings in psi versus total torque in ft-lb. Therefore, total package shaft horsepower had to be computed since there was no way to compute the shaft horsepower produced by an individual engine.

The combining gearbox torquemeter calibrations for gearbox S/N 4061 and 4064 are presented in figures 3 through 8, appendix II. The uninstalled test cell, United Aircraft of Canada, Limited, calibration fairings for the engine characteristics are shown on all engine characteristic plots except for engine S/N 66126. Engine S/N 66126 was not a calibrated engine.

Referred output shaft horsepower ($shp/\delta_{t_2}\sqrt{\theta_{t_2}}$) was determined by assuming that each engine was producing one-half of the total output shaft horsepower. This shaft horsepower derived for each engine was then referred to the compressor inlet condition existing at each of the compressor inlets. The referred shaft horsepowers for the two engines were then added together to obtain the total referred shaft horsepower.

Output shaft horsepower, fuel flow, gas producer turbine speed, and inter turbine temperature were generalized by the following relationships:

$$\frac{shp}{\delta_{t_2}\sqrt{\theta_{t_2}}} \text{ vs } \frac{N_g}{\sqrt{\theta_{t_2}}}$$

$$\frac{T_{t_5}}{\theta_{t_2}} \text{ vs } \frac{N_g}{\sqrt{\theta_{t_2}}}$$

$$\frac{W_f}{\delta_{t_2}\sqrt{\theta_{t_2}}} \text{ vs } \frac{N_g}{\sqrt{\theta_{t_2}}}$$

The engine characteristics data are presented in figures 127 through 138, and figures 142 through 153, appendix I.

FIGURES 1 THROUGH 166

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Symbol	Avg Gross Weight (Lb)	Method	Remarks
○	7830	Ground Speed Course	A/C S/N 776
□	8420	Tower Fly By	A/C S/N 776
△	8450	Ground Speed Course	A/C S/N 774
◇	8200	Ground Speed Course	A/C S/N 610

Notes:

1. Tailed symbols denote reciprocal headings.
2. Data obtained at mid cg.
3. Nose boom not installed on A/C S/N 774 or 610.
4. Data obtained in level flight.

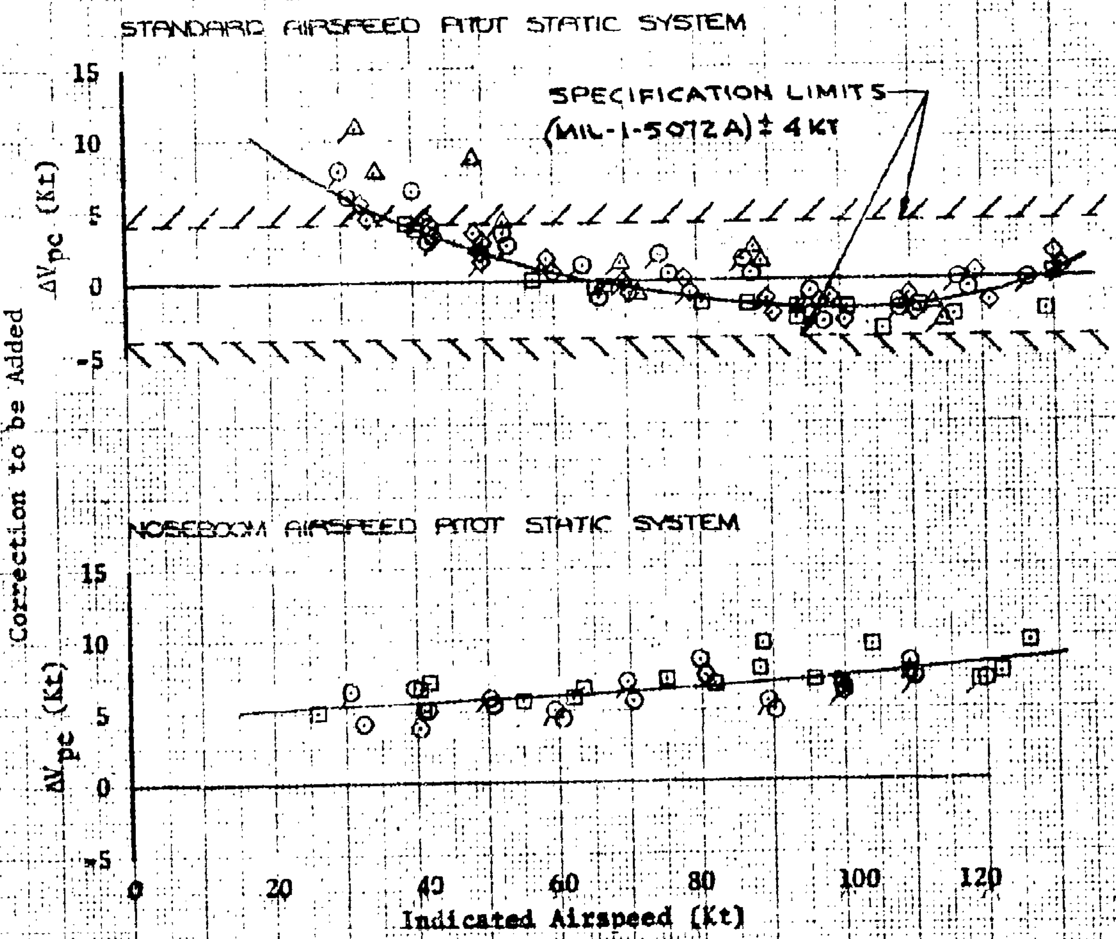


Figure 1 Airspeed Calibration-ΔV_{pc}

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SYMBOL	AVG GROSS WEIGHT (LB)	PRESSURE ALTITUDE (FT)	FLIGHT CONDITION
○	9,970	5,000	CLIMB
△	10,000	5,000	CLIMB
▽	8,610	5,000	CLIMB
○	10,140	10,000	CLIMB
▽	8,660	10,000	CLIMB
▽	8,590	10,000	AUTOROTATION
△	10,040	5,000	AUTOROTATION
○	10,000	5,000	AUTOROTATION
D	10,210	10,000	AUTOROTATION
○	9,840	10,000	AUTOROTATION
◁	8,600	5,000	AUTOROTATION
▷	8,480	5,000	AUTOROTATION
▽	8,620	5,000	AUTOROTATION
○	9,970	10,000	AUTOROTATION
☆	8,470	14,000	CLIMB

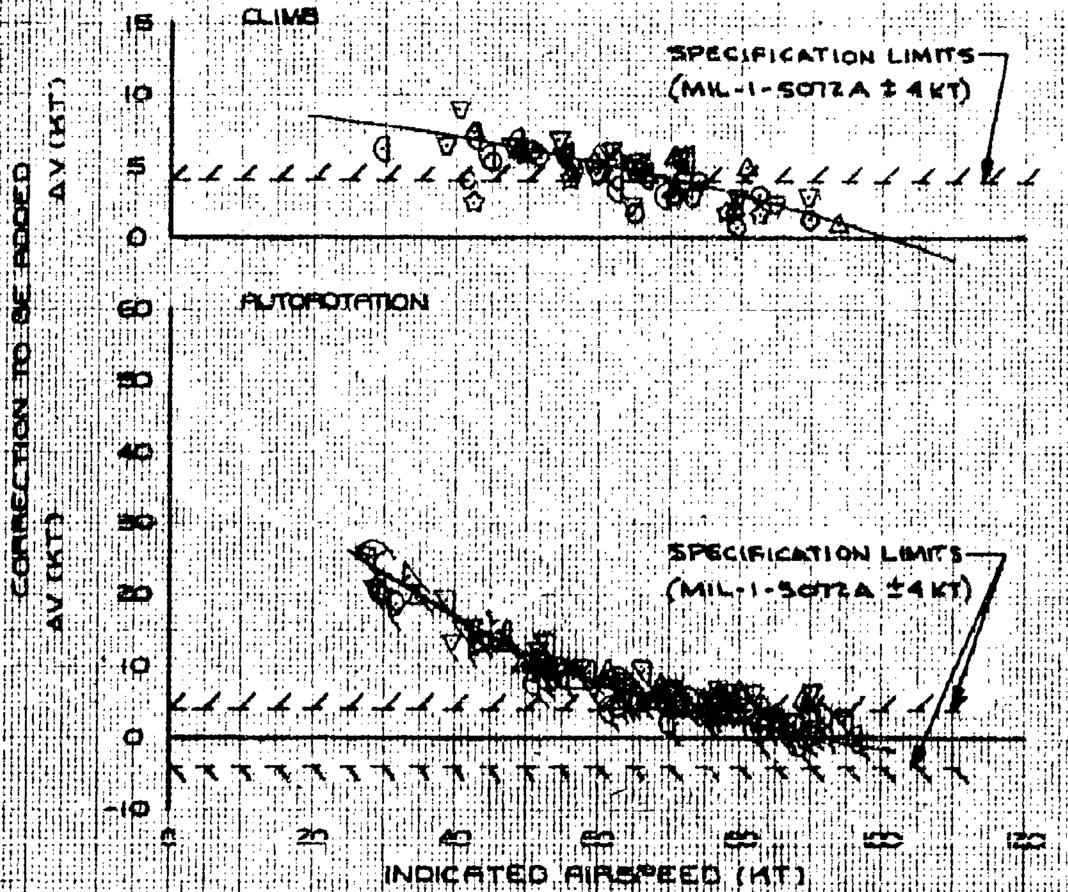


FIGURE 2 AIRSPEED CALIBRATION – STANDARD SYSTEM

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Symbol	Avg Gross Weight (Lb)	Method	Remarks
○	7,830	Ground Speed Course	A/C S/N 776
□	8,420	Tower Fly By	A/C S/N 776
△	8,450	Ground Speed Course	A/C S/N 774
◇	8,200	Ground Speed Course	A/C S/N 610

Notes:
1. Tailed symbols denote reciprocal headings.
2. Data obtained at mid cg.
3. Nose boom not installed on A/C 774 or 610.
4. Data obtained in level flight.

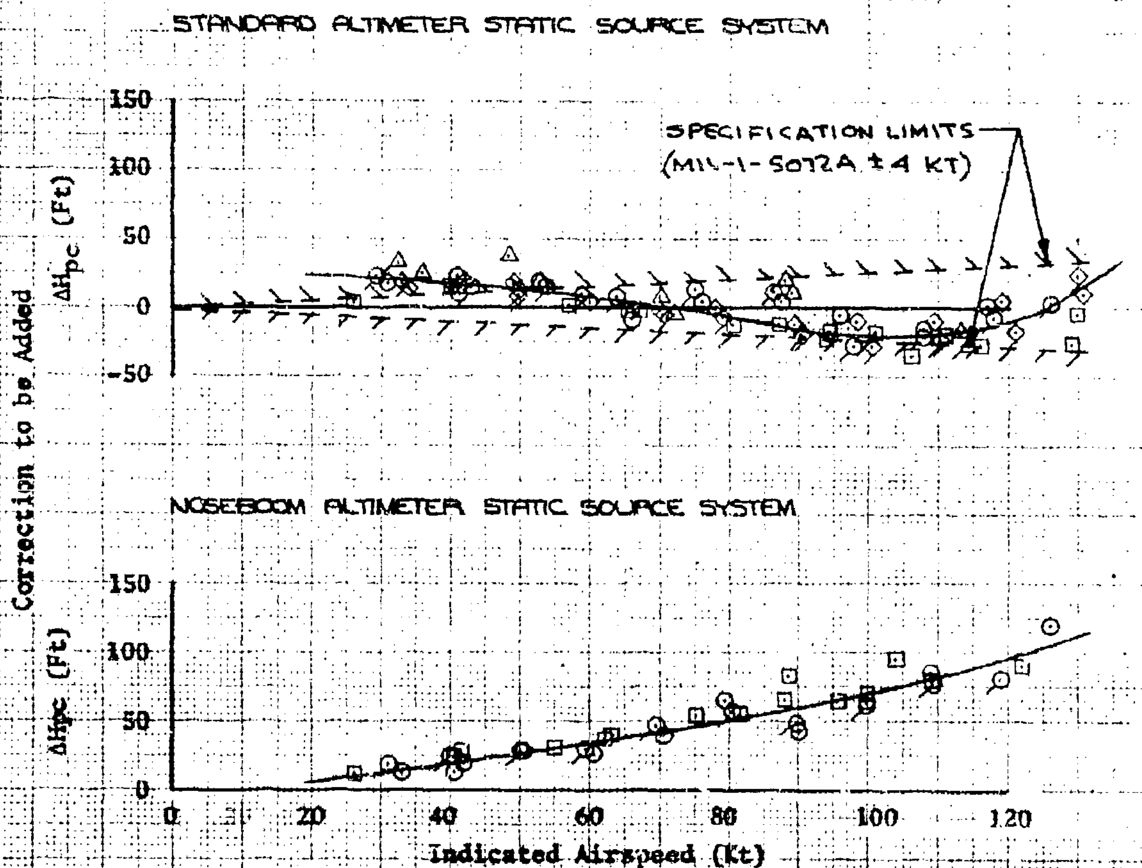


 FIGURE 3 ALTIMETER STATIC SOURCE CALIBRATION

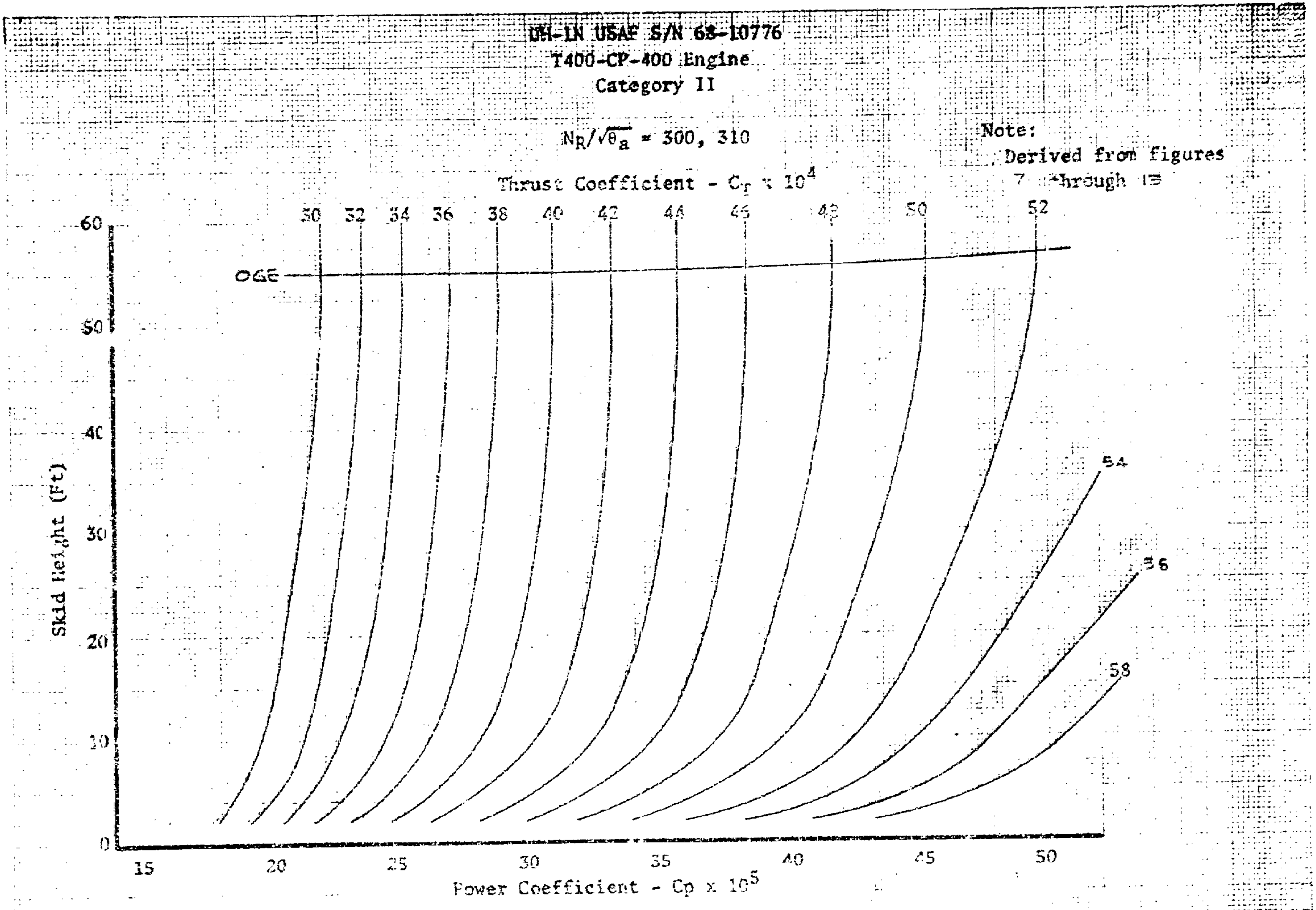


Figure 4 Nondimensional Hovering Performance Summary

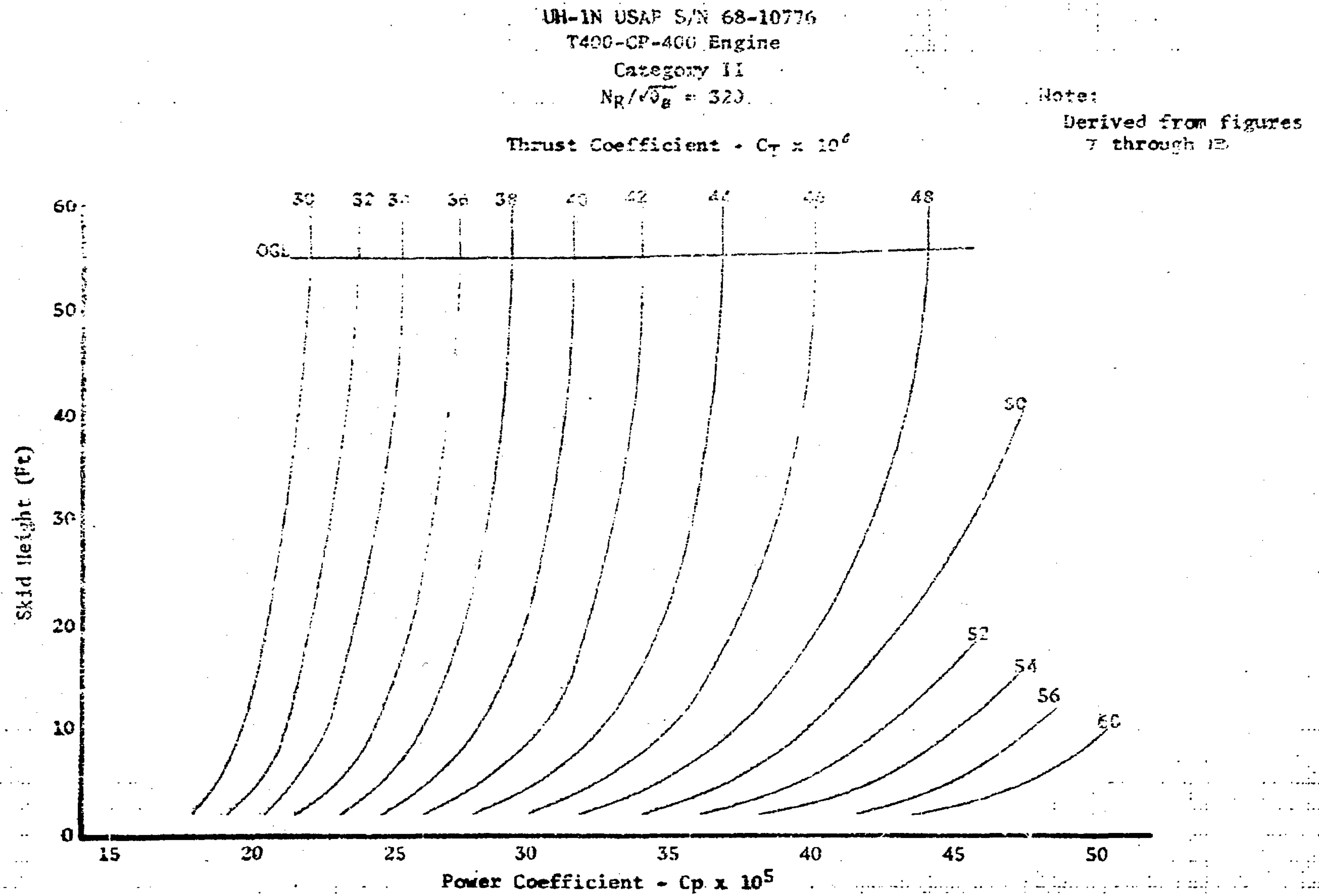


Figure 5 Nondimensional Hovering Performance Summary

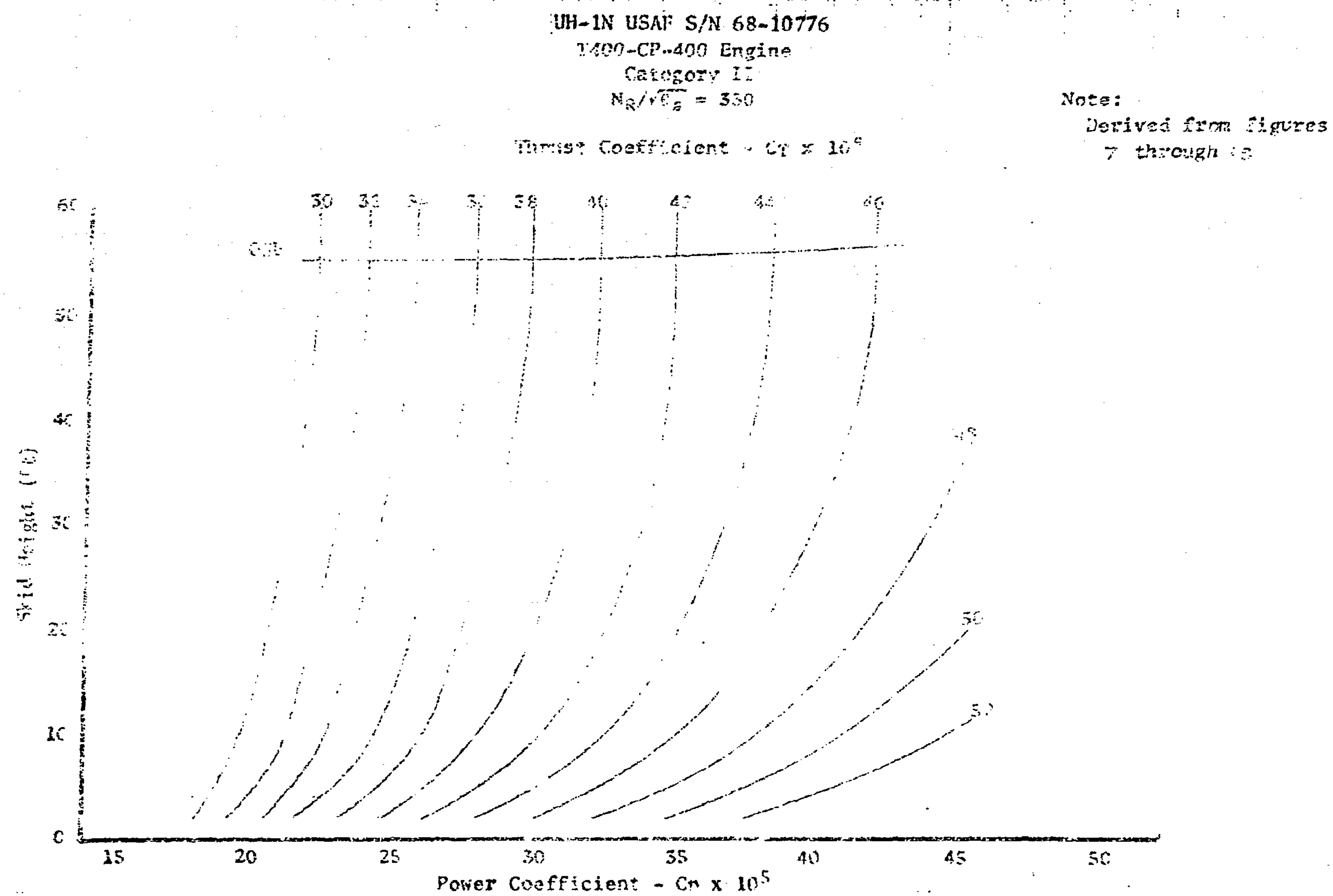


Figure 6 Nondimensional Hovering Performance Summary

UH-1N USAF S/N 68-1
T400-CP-400 ENGI
CATEGORY II
SKID HEIGHT = 2 FT

SYM	$N_R/\sqrt{\theta_a}$ (RPM)	AVG ROTOR SPEED (RPM)	M_{TIP}	PRESSURE ALTITUDE (FT)	FREE AIR TEMP (°C)
○	300	297	0.6749	9,560	9.0
△ (flagged)	310	301	0.6973	2,130	-7.0
△	310	306	0.6973	9,560	8.0
◇ (flagged)	320	312	0.7198	1,990	-1.0
◇	320	316	0.7198	[illegible]	8.0
□ (flagged)	330	321	0.7423	[illegible]	-1.0
□	330	319	0.7423	[illegible]	-4.0
□ (flagged)	330	317	0.7423	10,110	-6.0

NOTES:
1. WINDS LESS THAN 3 KNOTS.
2. SOLID SYMBOLS DENOTE FREE FLIGHT HOVER.
3. VERTICAL DISTANCE FROM BOTTOM OF SKID TO CENTER OF ROTOR HUB = 12 FT.

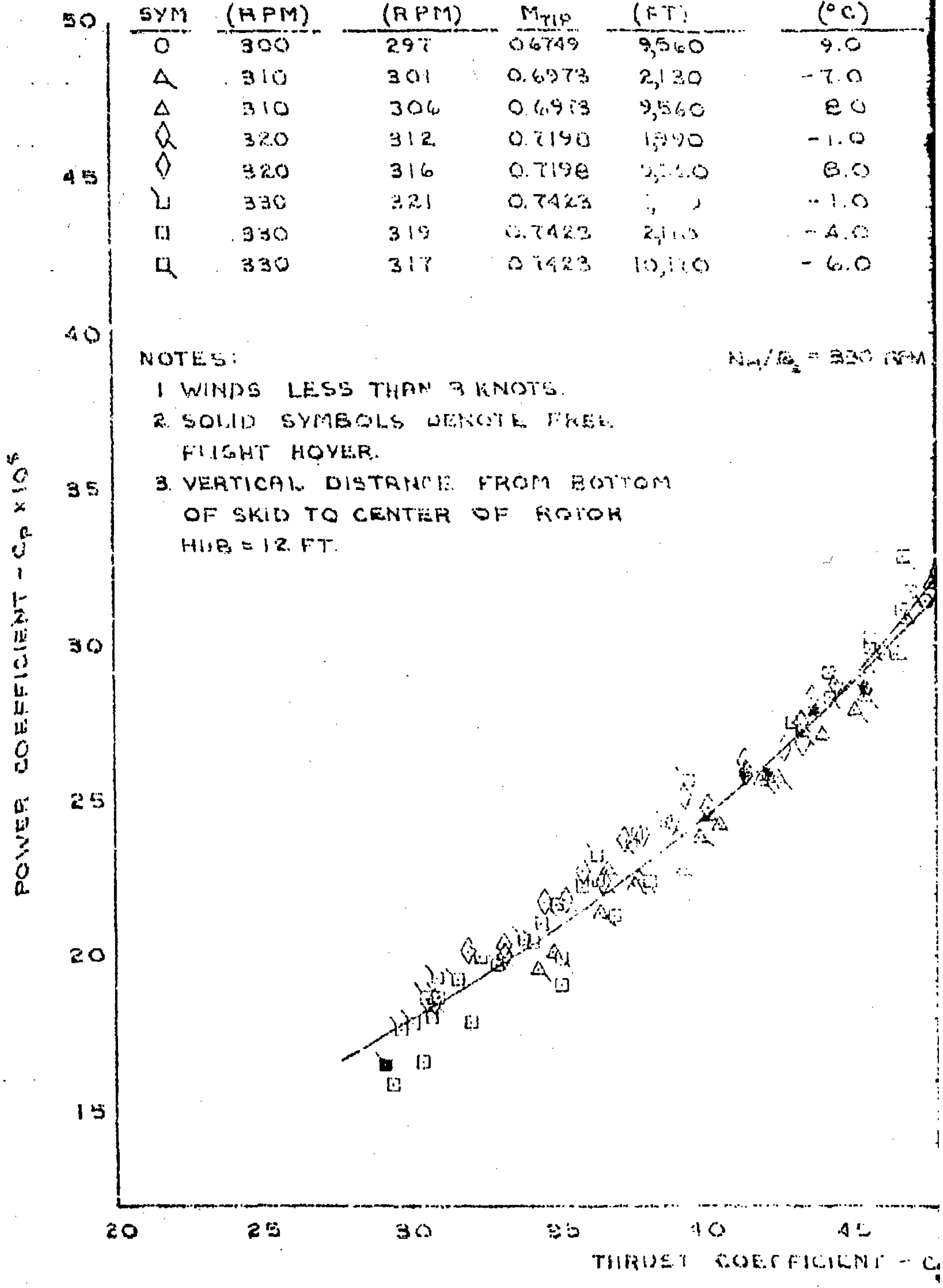
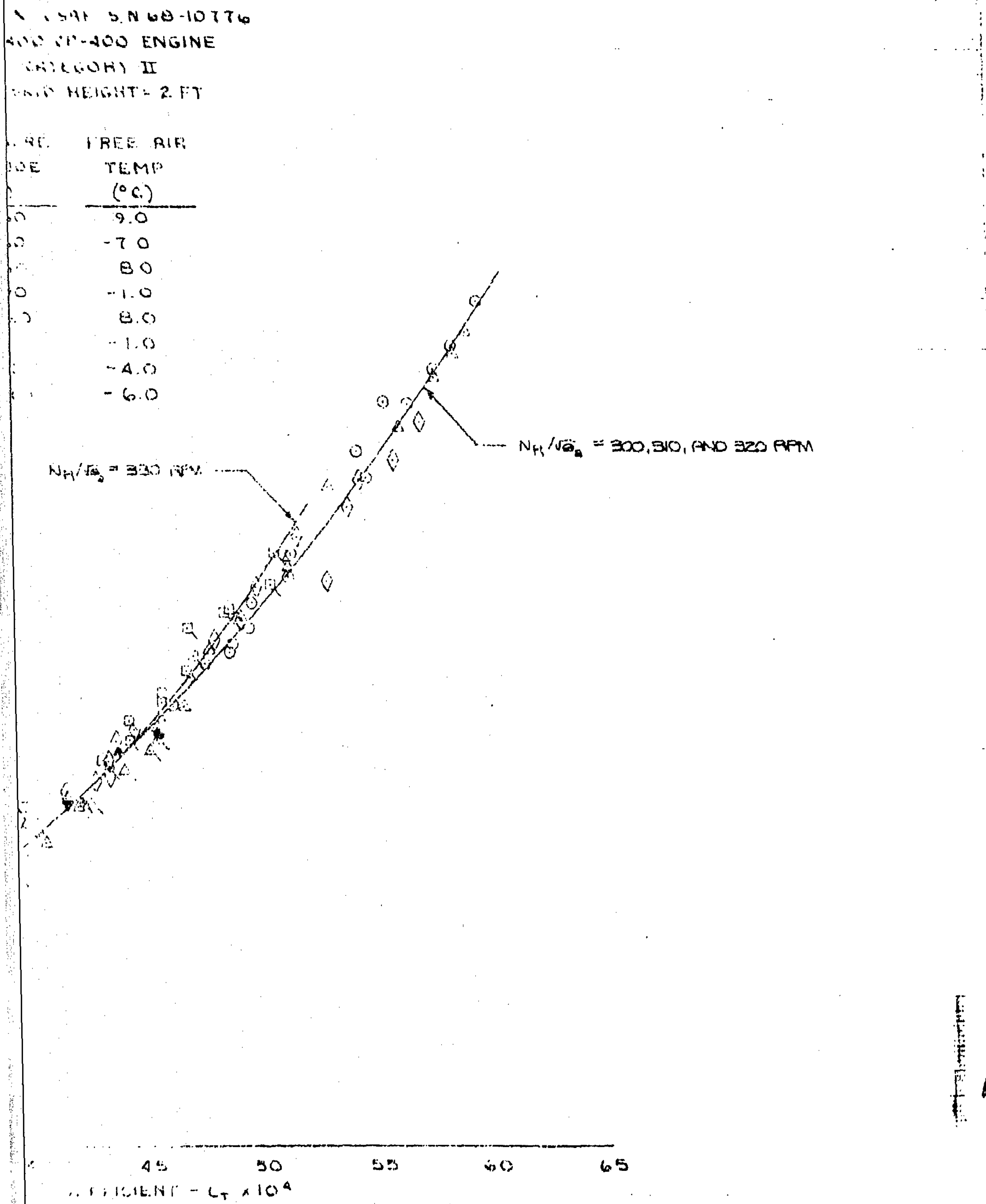


FIGURE 7 NONDIMENSIONAL HOVERIN

PRECEDING PAGE BLANK-NOT FILMED



...RING PERFORMANCE

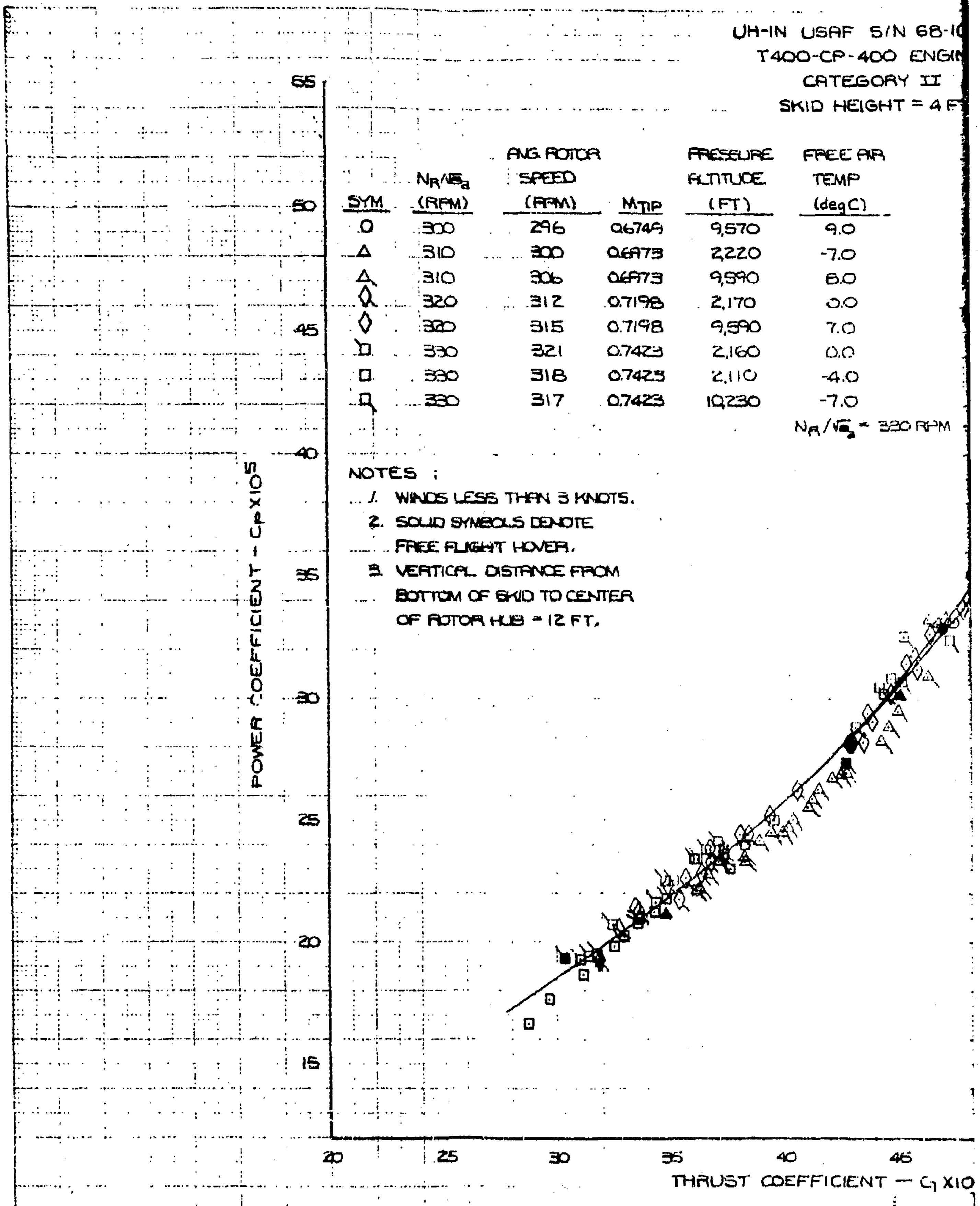
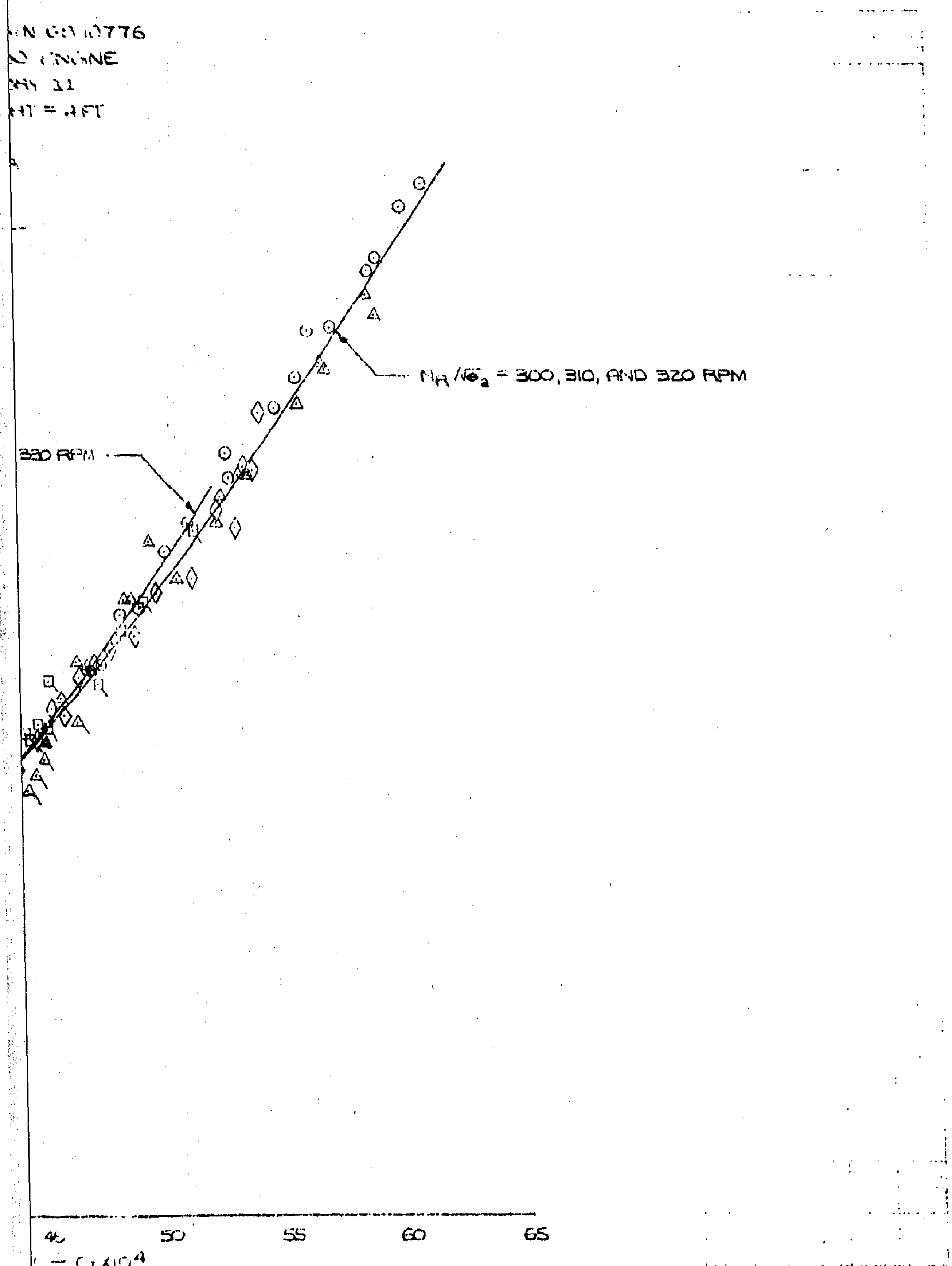


FIGURE 8 NONDIMENSIONAL HOVERING



PERFORMANCE

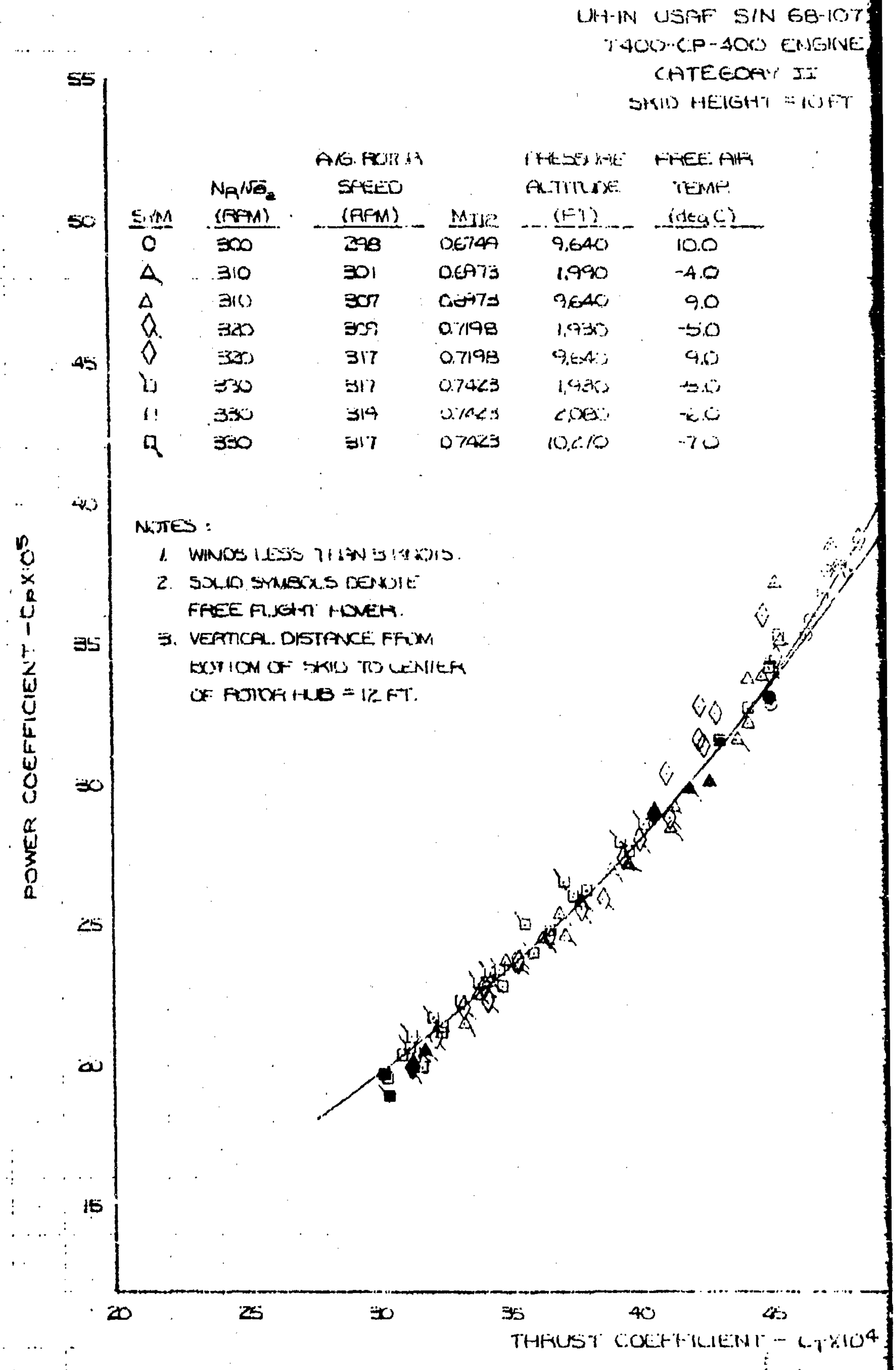
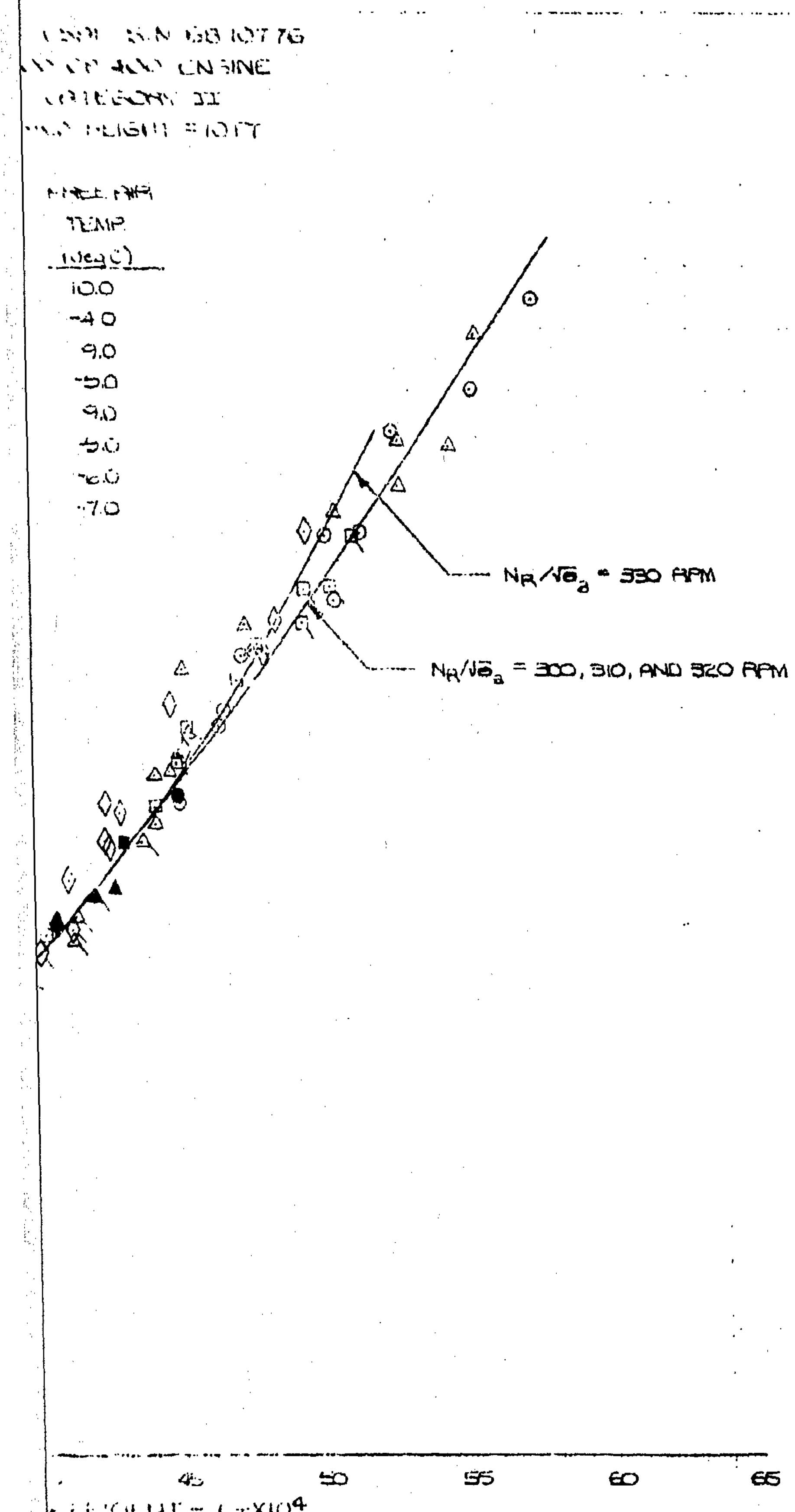


FIGURE 9 NONDIMENSIONAL HOVERING



HOVERING PERFORMANCE

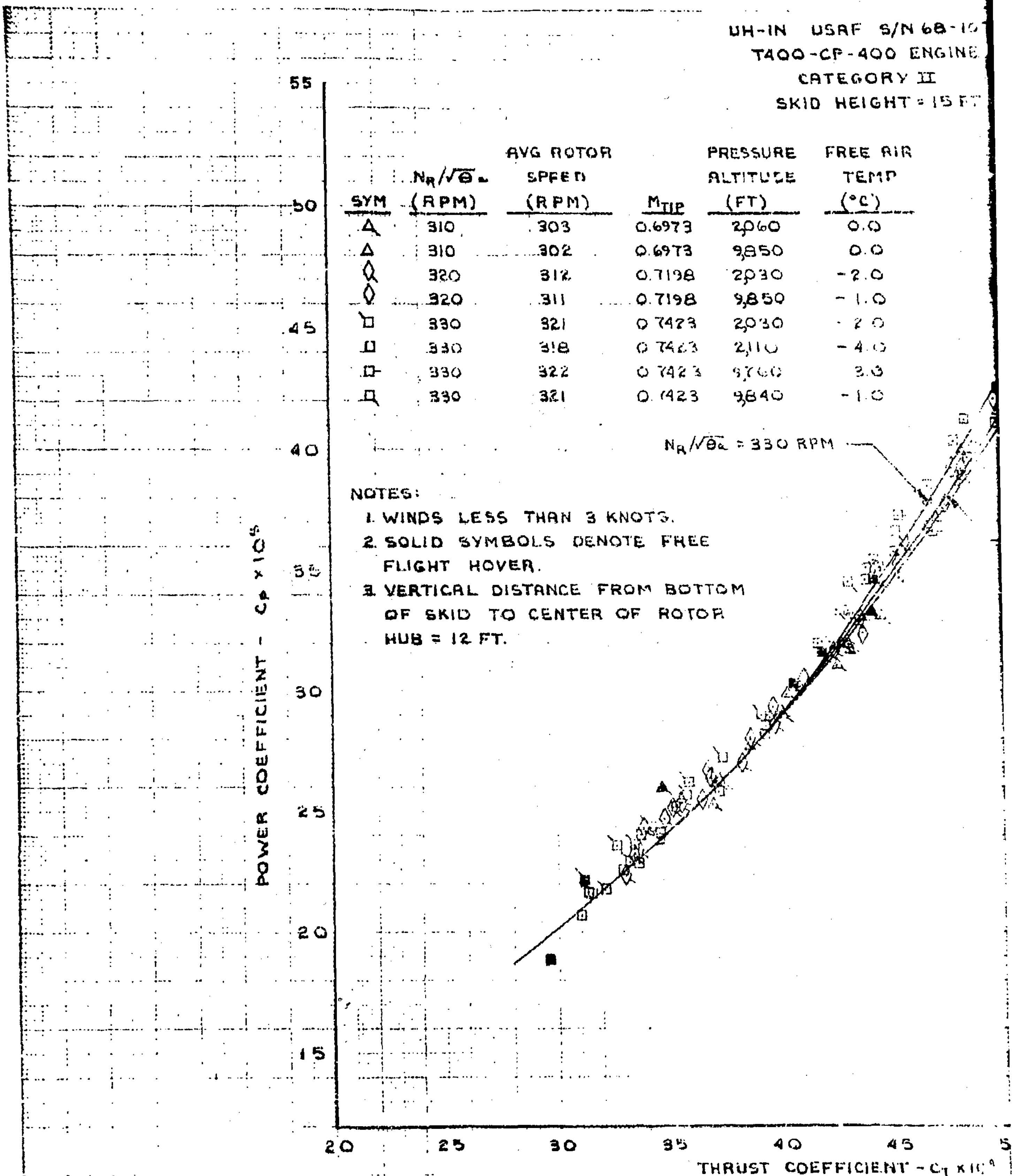
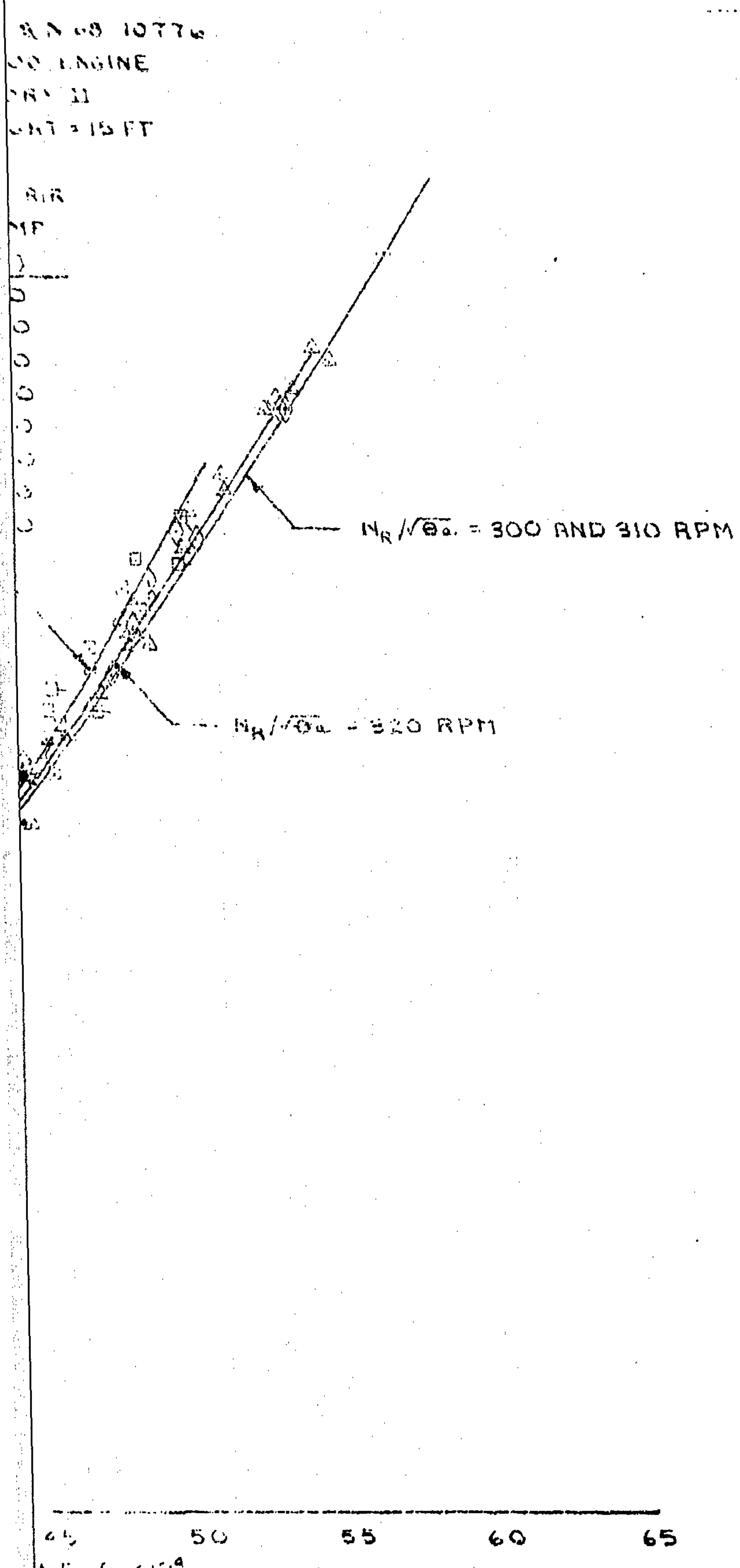
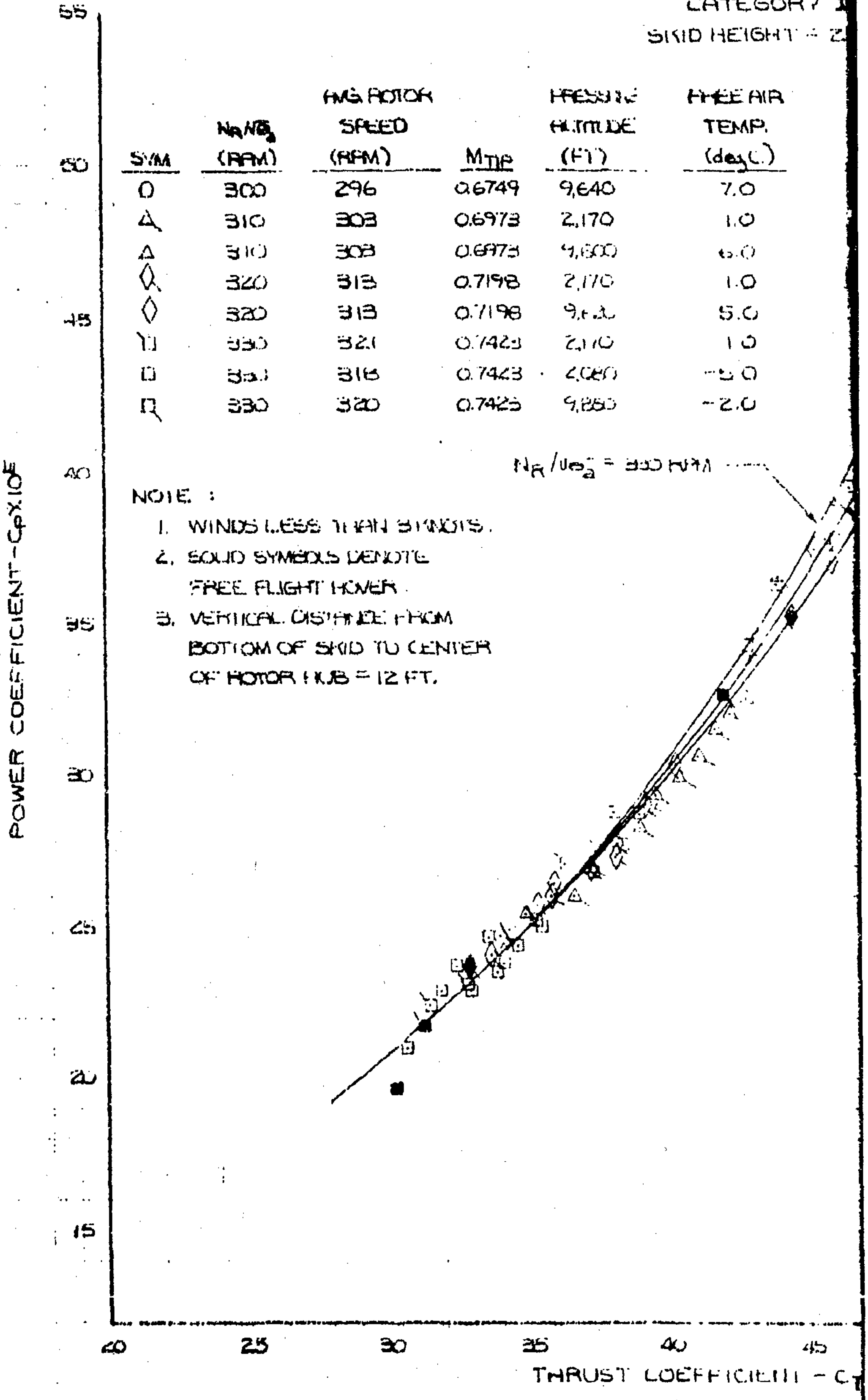


FIGURE 10 NONDIMENSIONAL HOVERING PER



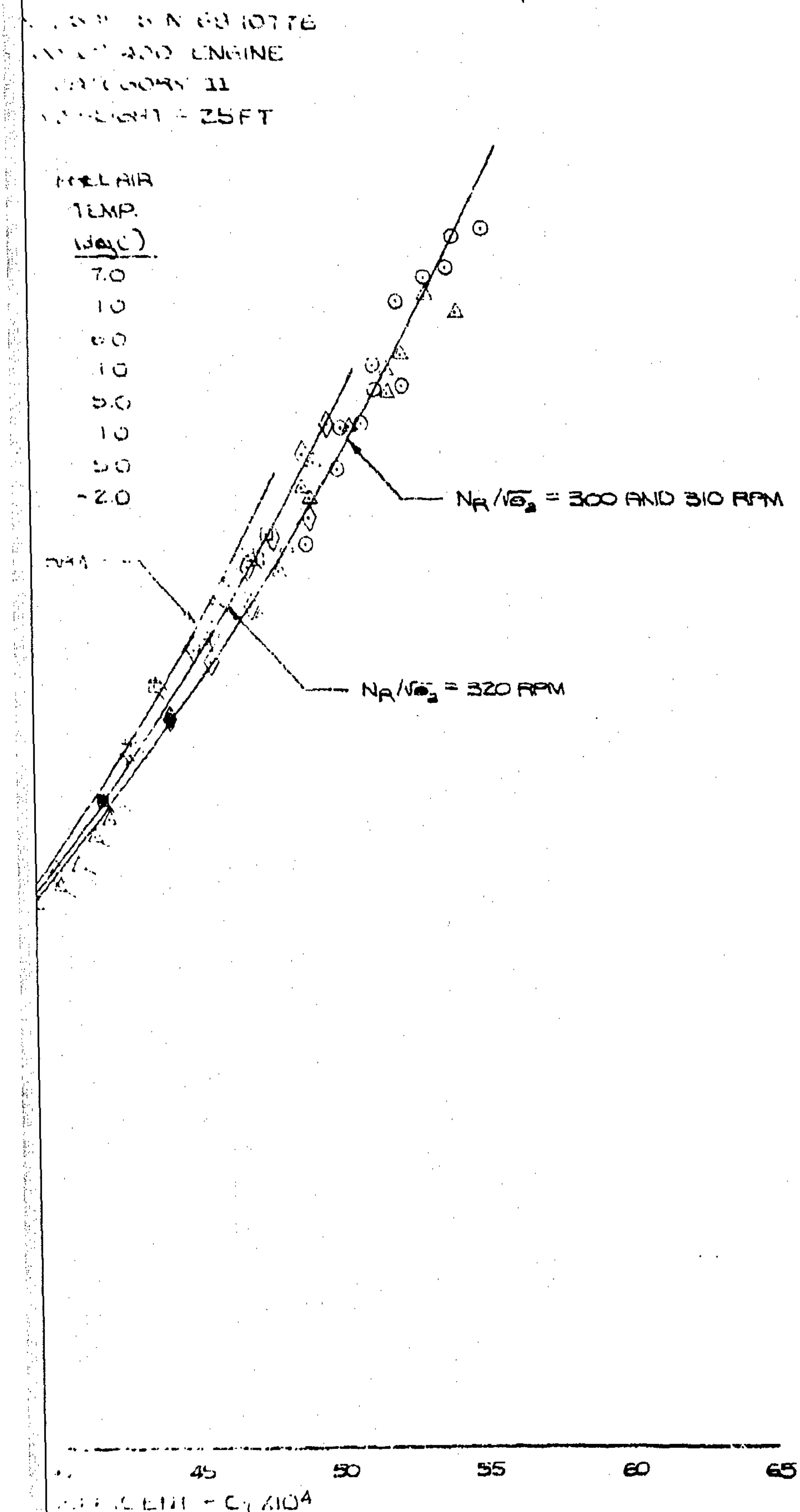
PERFORMANCE

UH-1H USAF S/N G
T400-CP-400 EN
CATEGORY I
SKID HEIGHT = 2



SYM	$N_R/\sqrt{\theta_a}$ (RPM)	AVG ROTOR SPEED (RPM)	M_{TIP}	PRESSURE ALTITUDE (FT)	FREE AIR TEMP. (deg C)
O	300	296	0.6749	9,640	7.0
△ (flagged)	310	303	0.6973	2,170	1.0
△	310	303	0.6973	9,600	6.0
◇ (flagged)	320	313	0.7198	2,170	1.0
◇	320	313	0.7198	9,630	5.0
□	330	321	0.7423	2,170	1.0
□	330	318	0.7423	2,080	-5.0
□ (flagged)	330	320	0.7425	9,860	-2.0

FIGURE 11 NONDIMENSIONAL HOVERING PER



2

...VERING PERFORMANCE

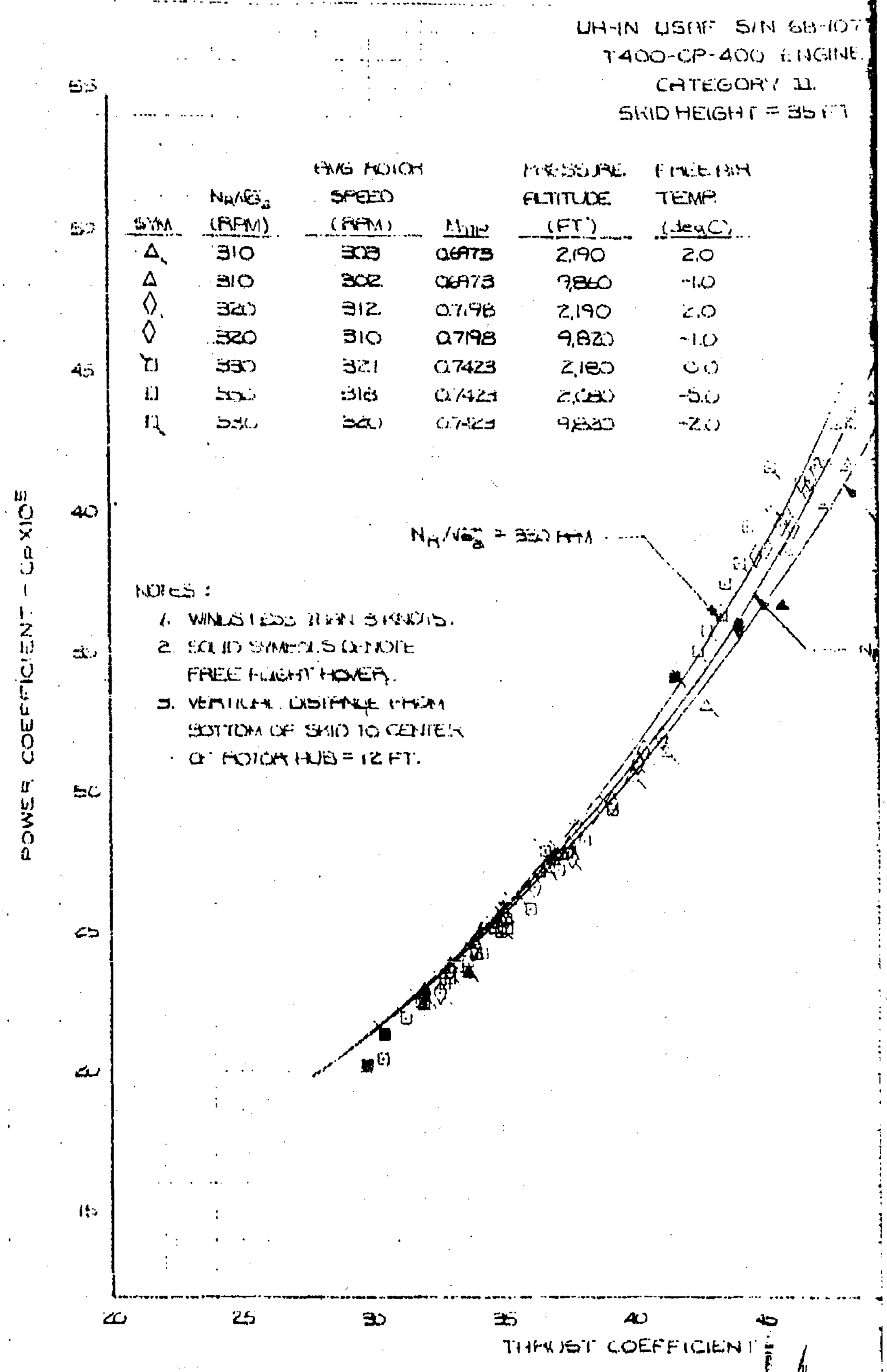
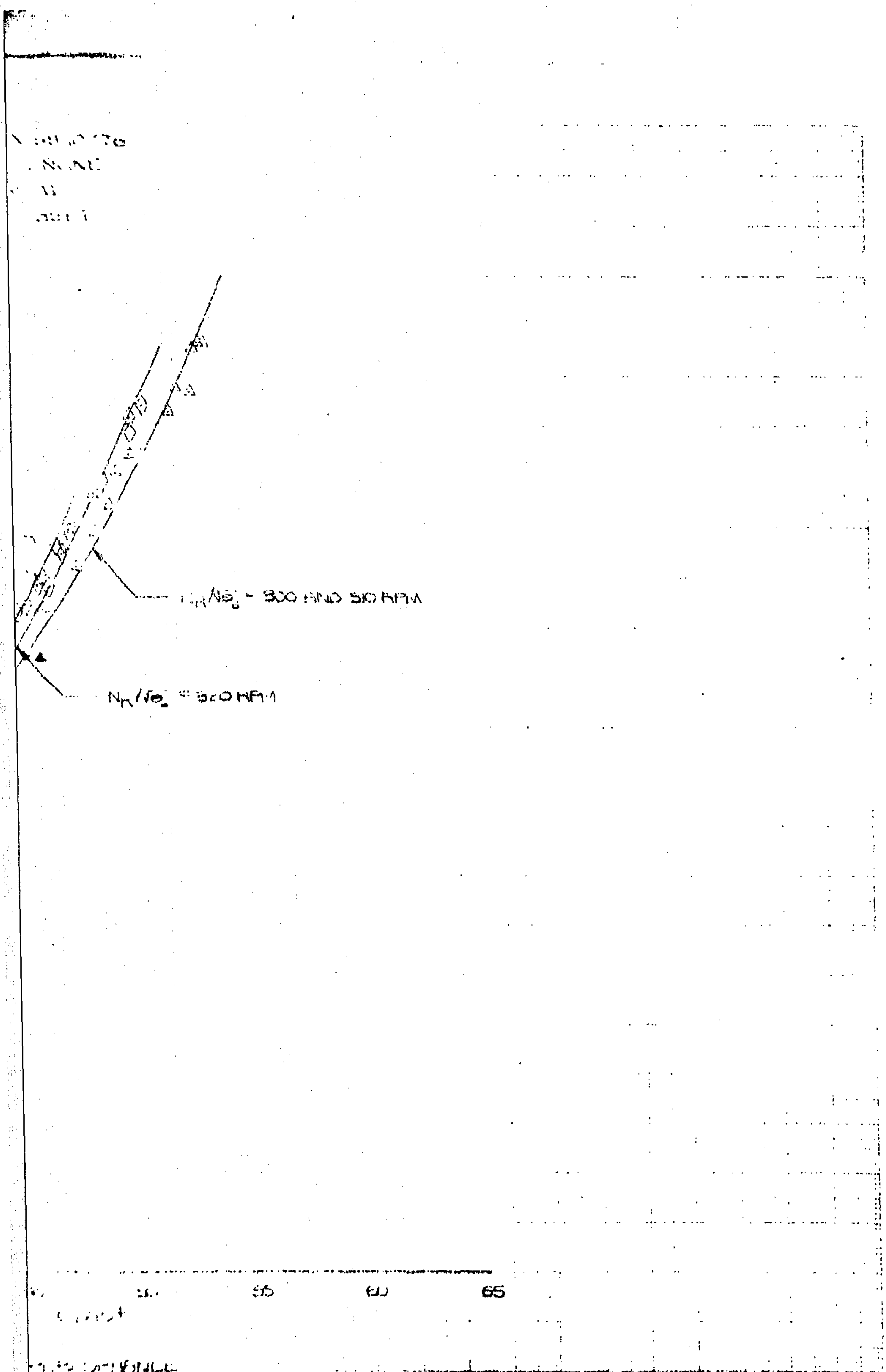


FIGURE 12 NONDIMENSIONAL HOVERING P



12

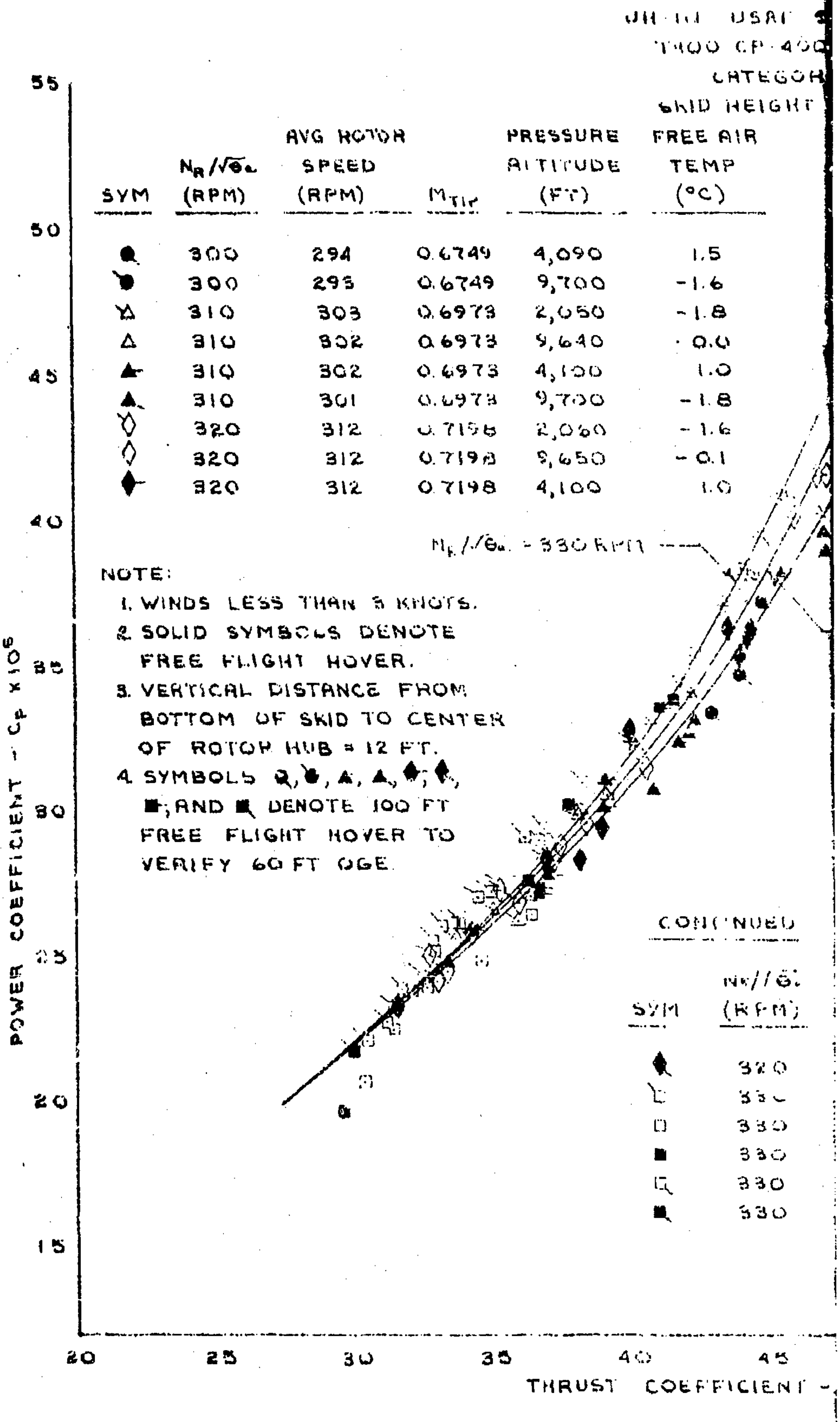
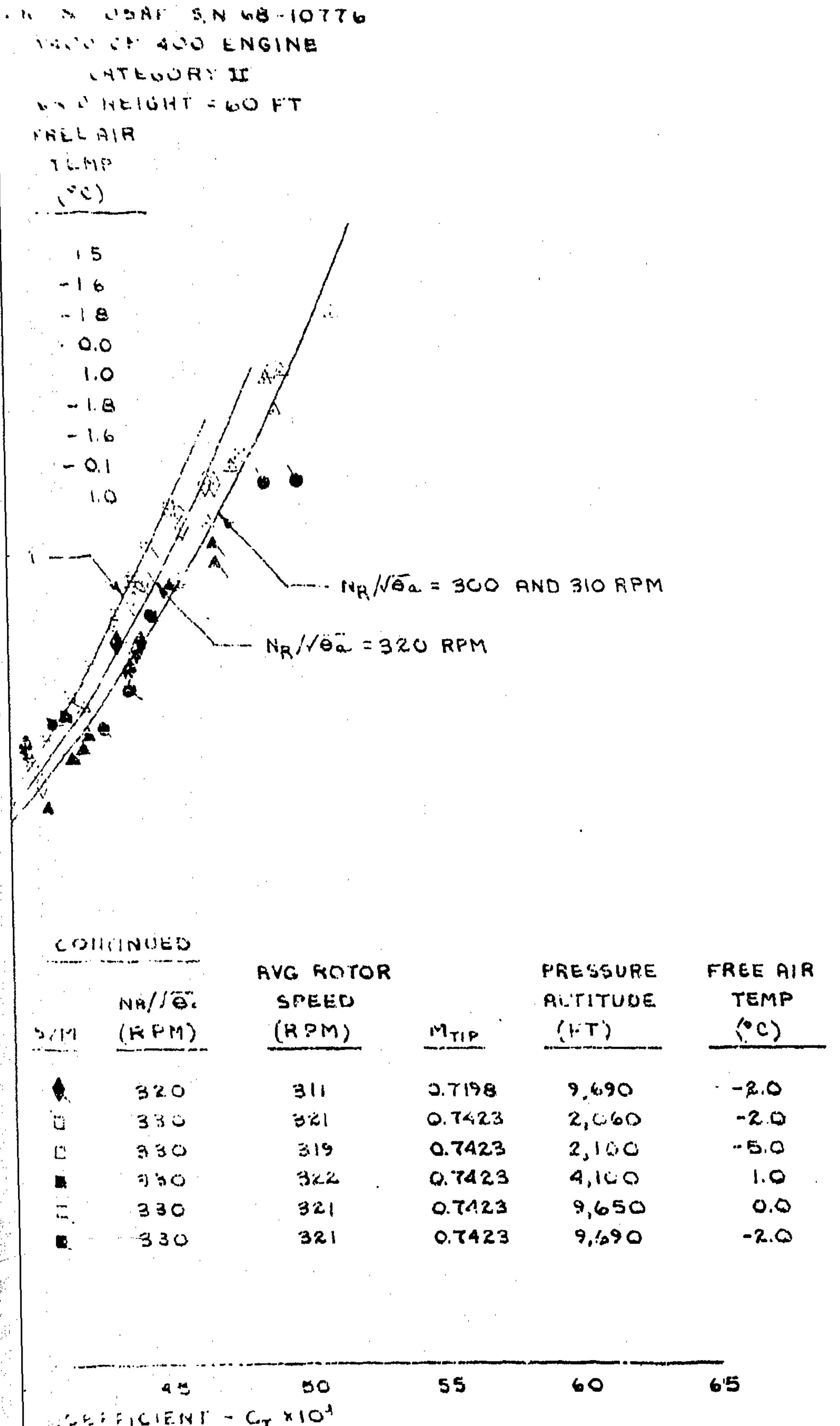


FIGURE 13 NONDIMENSIONAL HOVERING PERFO



CONTINUED

SYM	$N_R/\sqrt{\theta_a}$ (RPM)	AVG ROTOR SPEED (RPM)	M_{TIP}	PRESSURE ALTITUDE (FT)	FREE AIR TEMP (°C)
◆	320	311	0.7198	9,690	-2.0
◻	330	321	0.7423	2,060	-2.0
◻	330	319	0.7423	2,100	-5.0
■	330	322	0.7423	4,100	1.0
◻	330	321	0.7423	9,650	0.0
■	330	321	0.7423	9,690	-2.0

PERFORMANCE

12

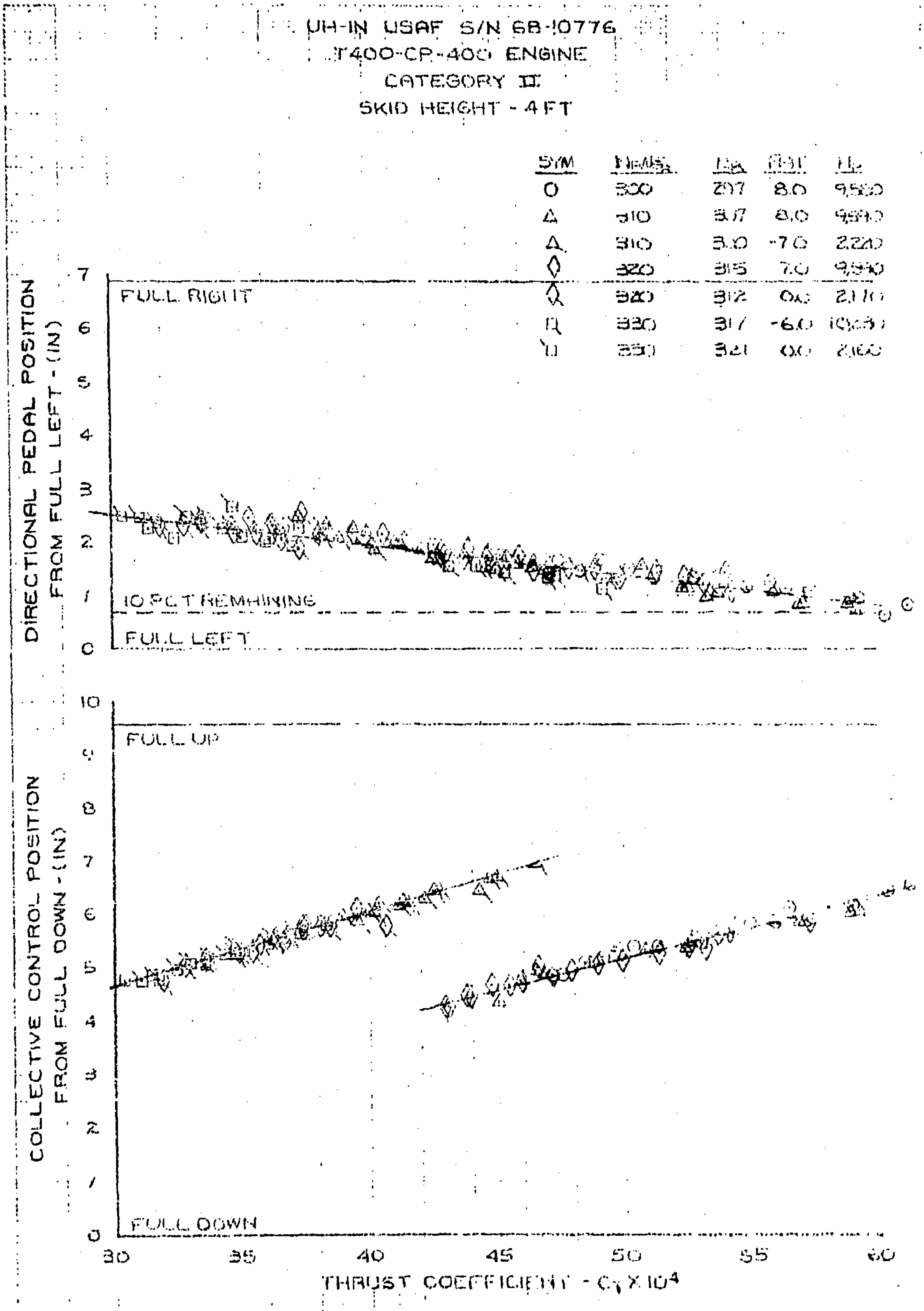


FIGURE 14 FLIGHT CONTROL POSITIONS IN HOVERING FLIGHT

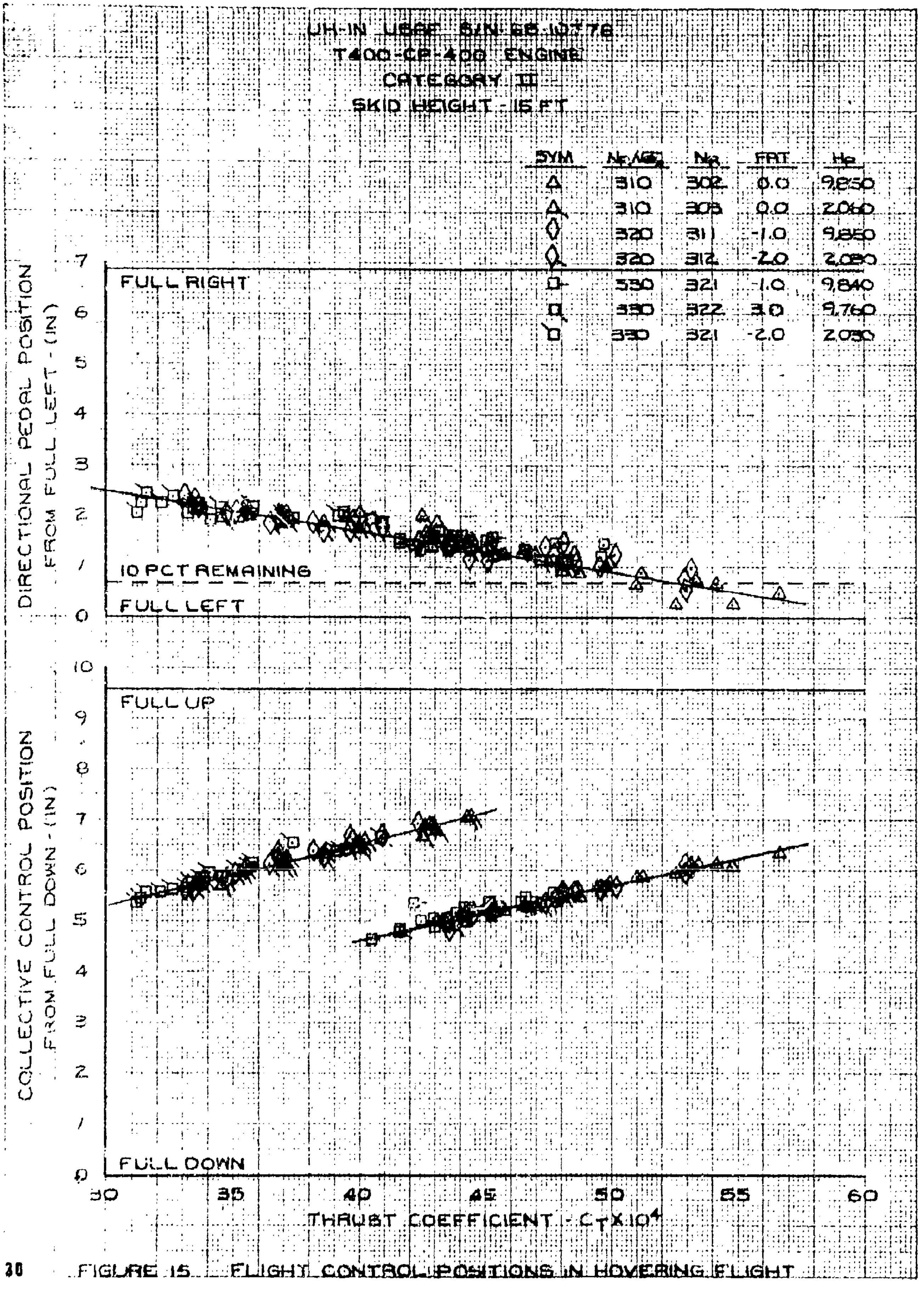


FIGURE 15 FLIGHT CONTROL POSITIONS IN HOVERING FLIGHT

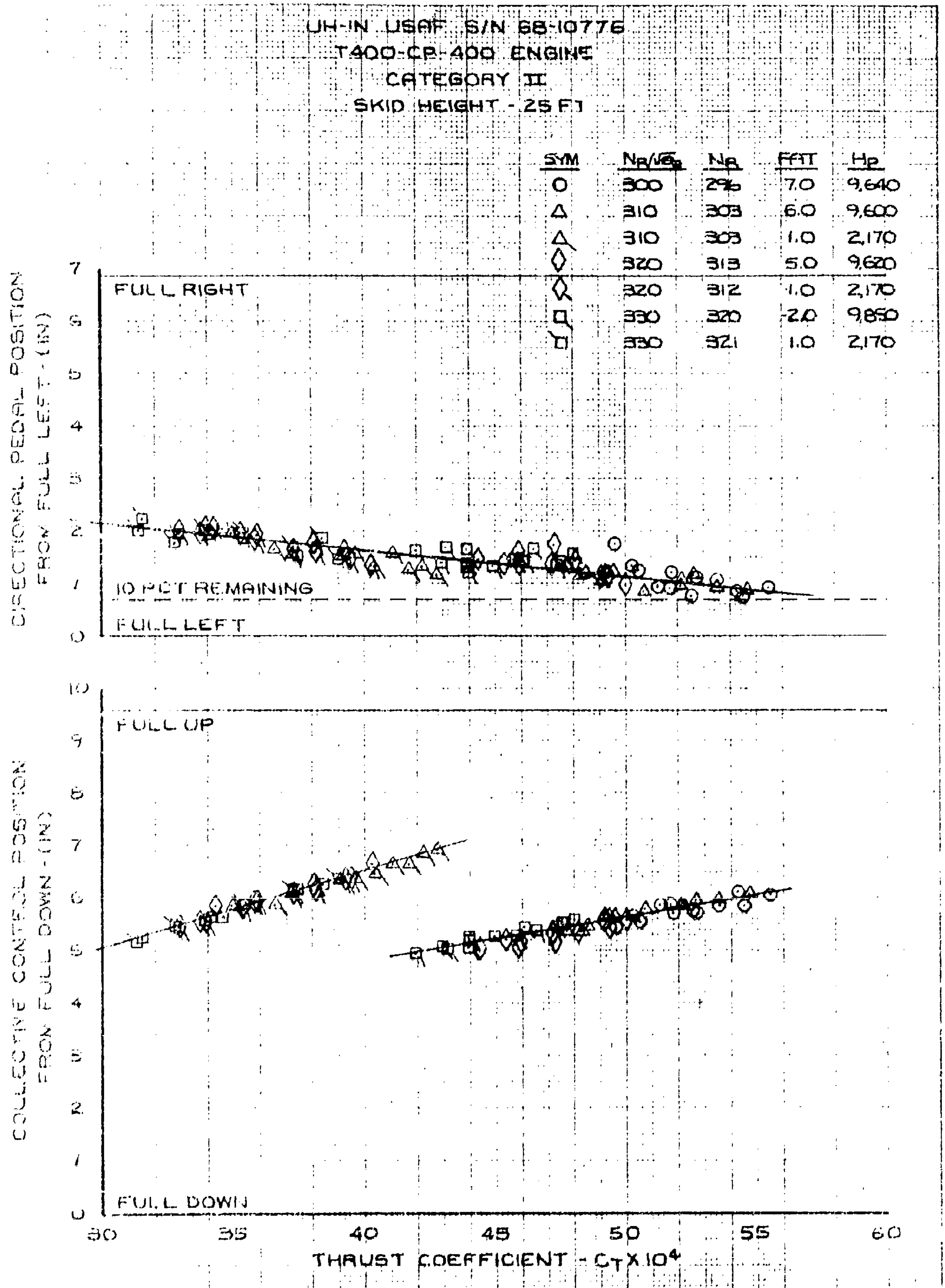


FIGURE 16 FLIGHT CONTROL POSITIONS IN HOVERING FLIGHT

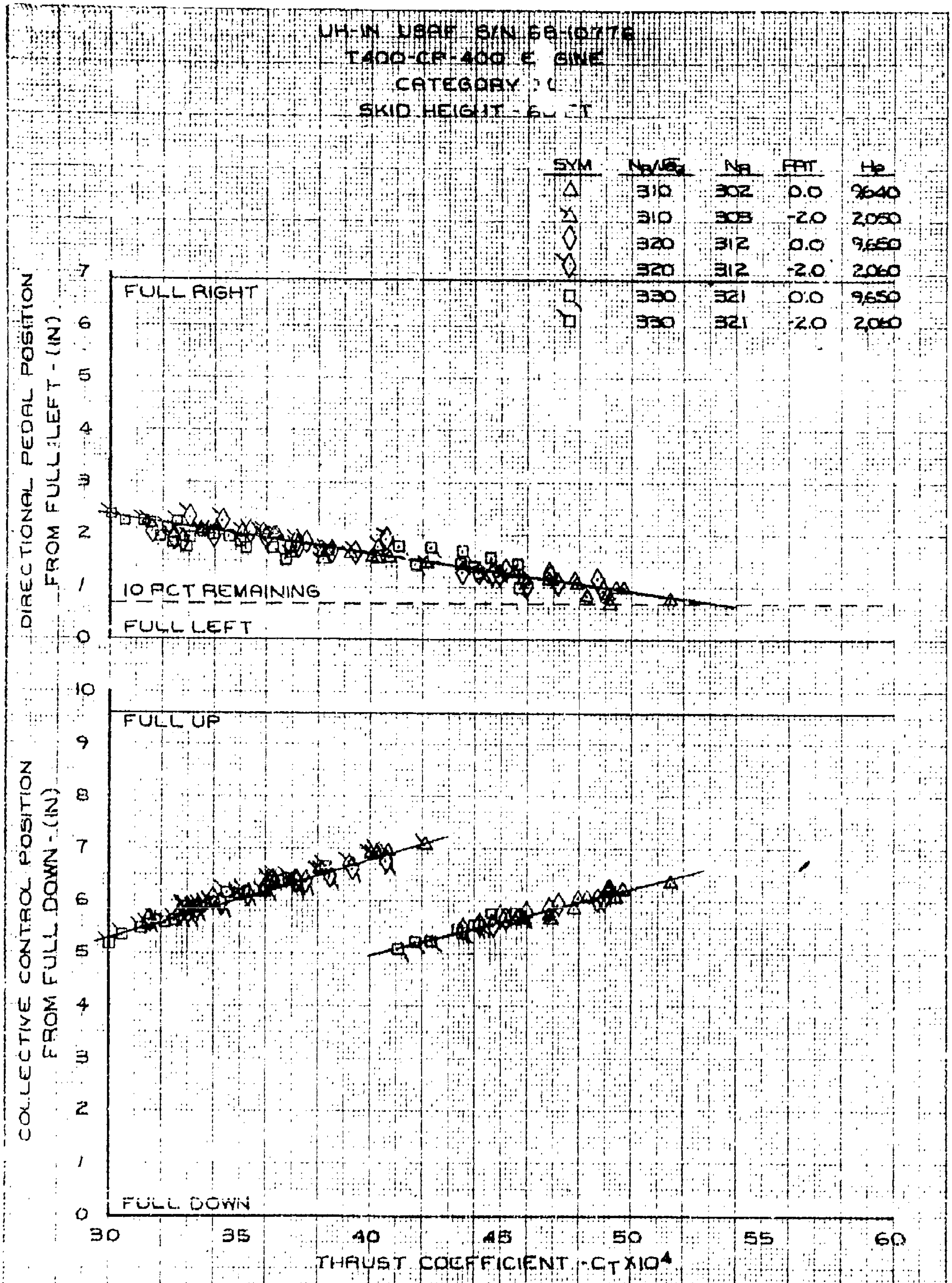


 FIGURE 17 FLIGHT CONTROL POSITIONS IN HOVERING FLIGHT

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

TECHNIQUE
LEVEL ACCELERATION FROM A 4-FT HOVER -
WITHOUT ROTOR SPEED BLEED

NOTE :
1. CURVES DERIVED FROM FIGURES 19 THROUGH 21
2. DO NOT EXTRAPOLATE DATA

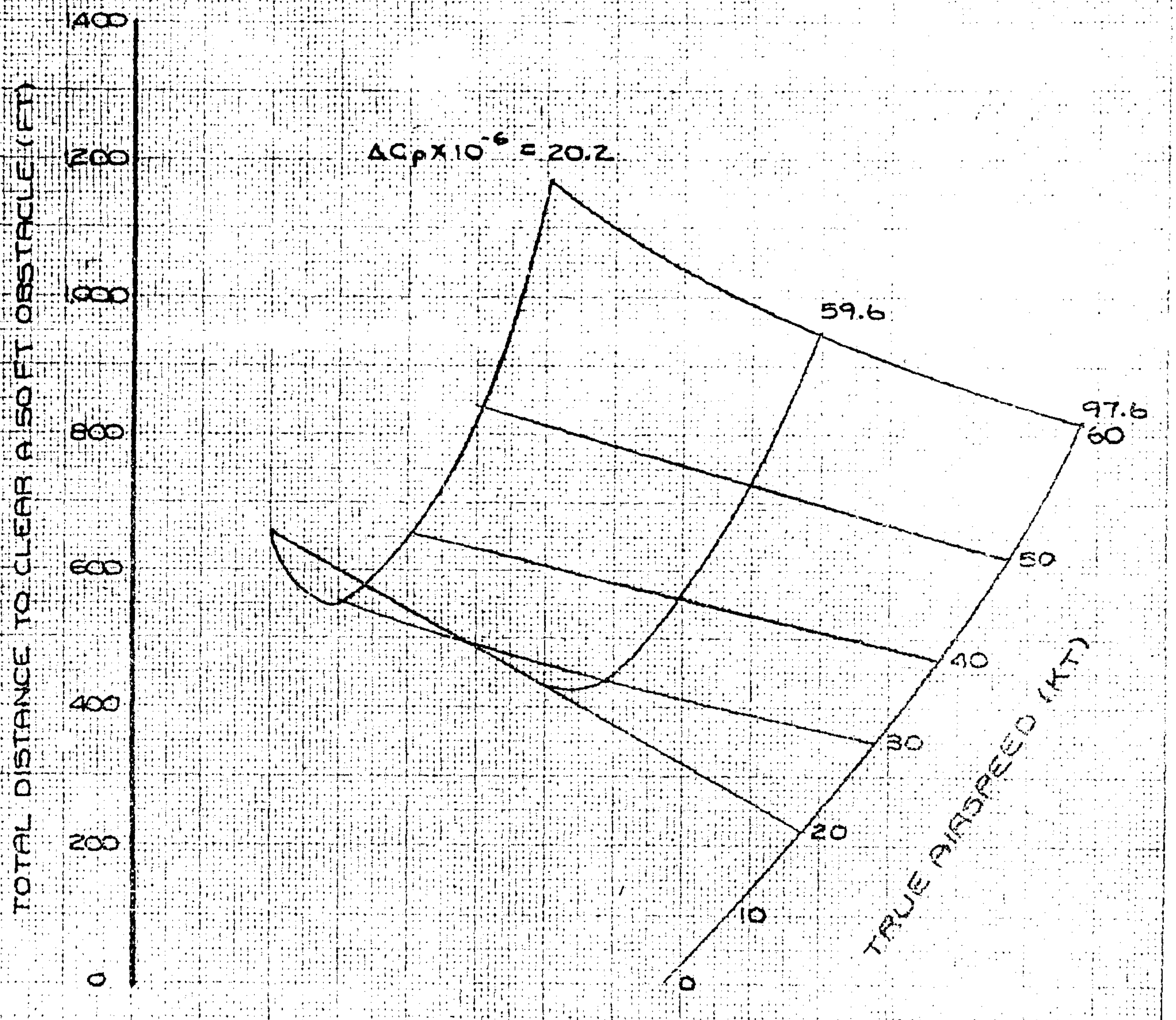
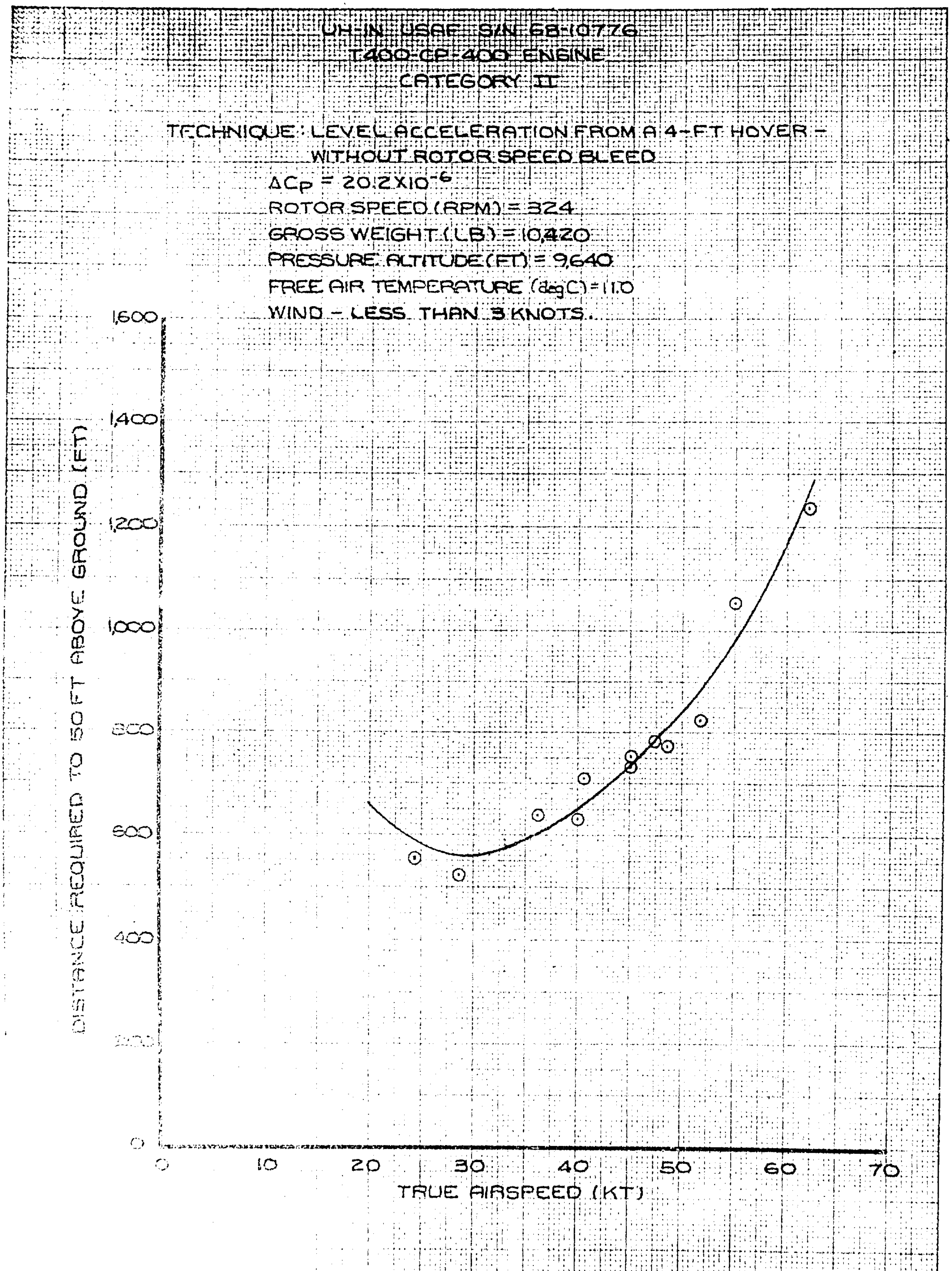


FIGURE 18 NONDIMENSIONAL TAKEOFF PERFORMANCE



TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

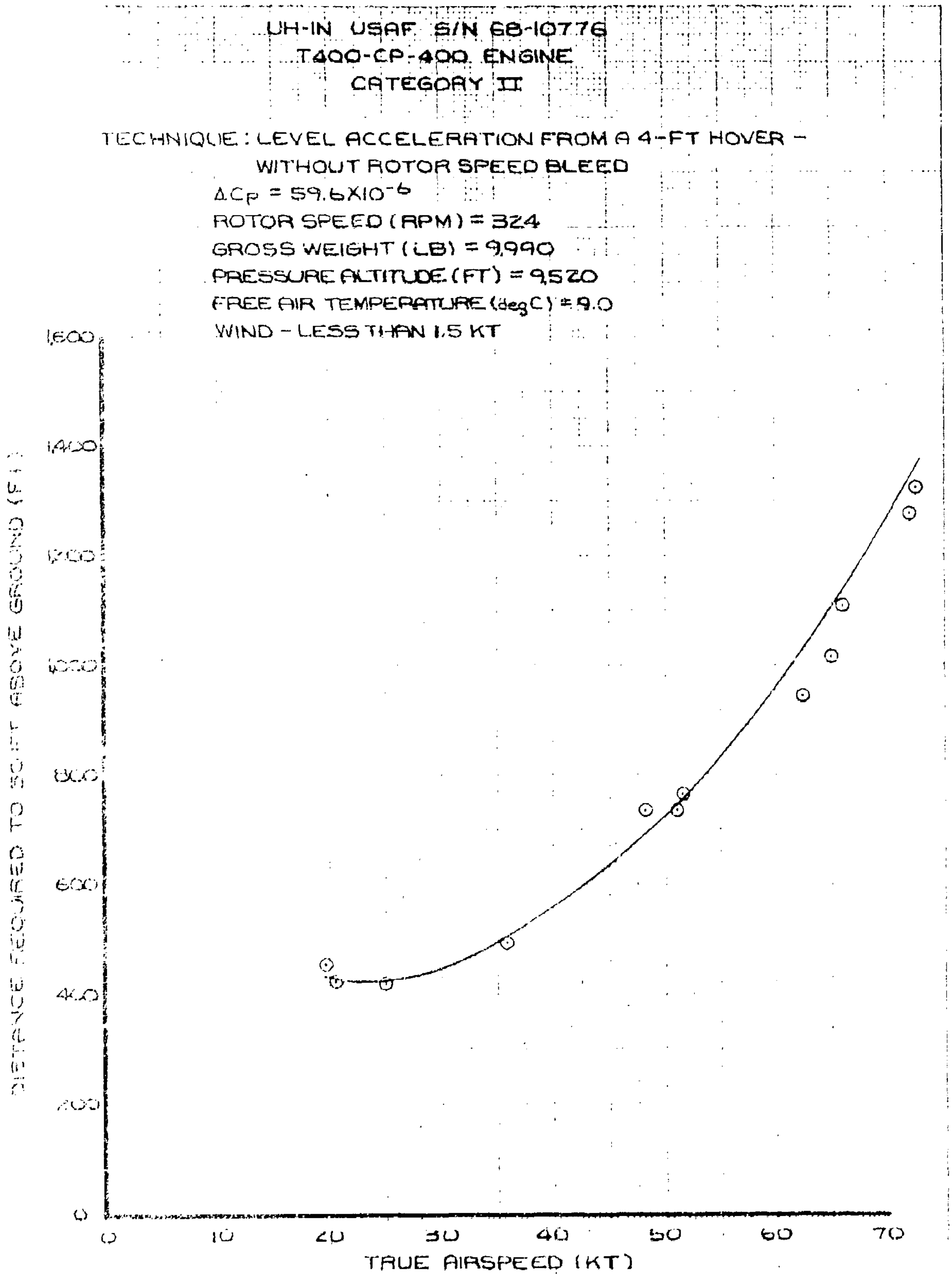


FIGURE 20 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

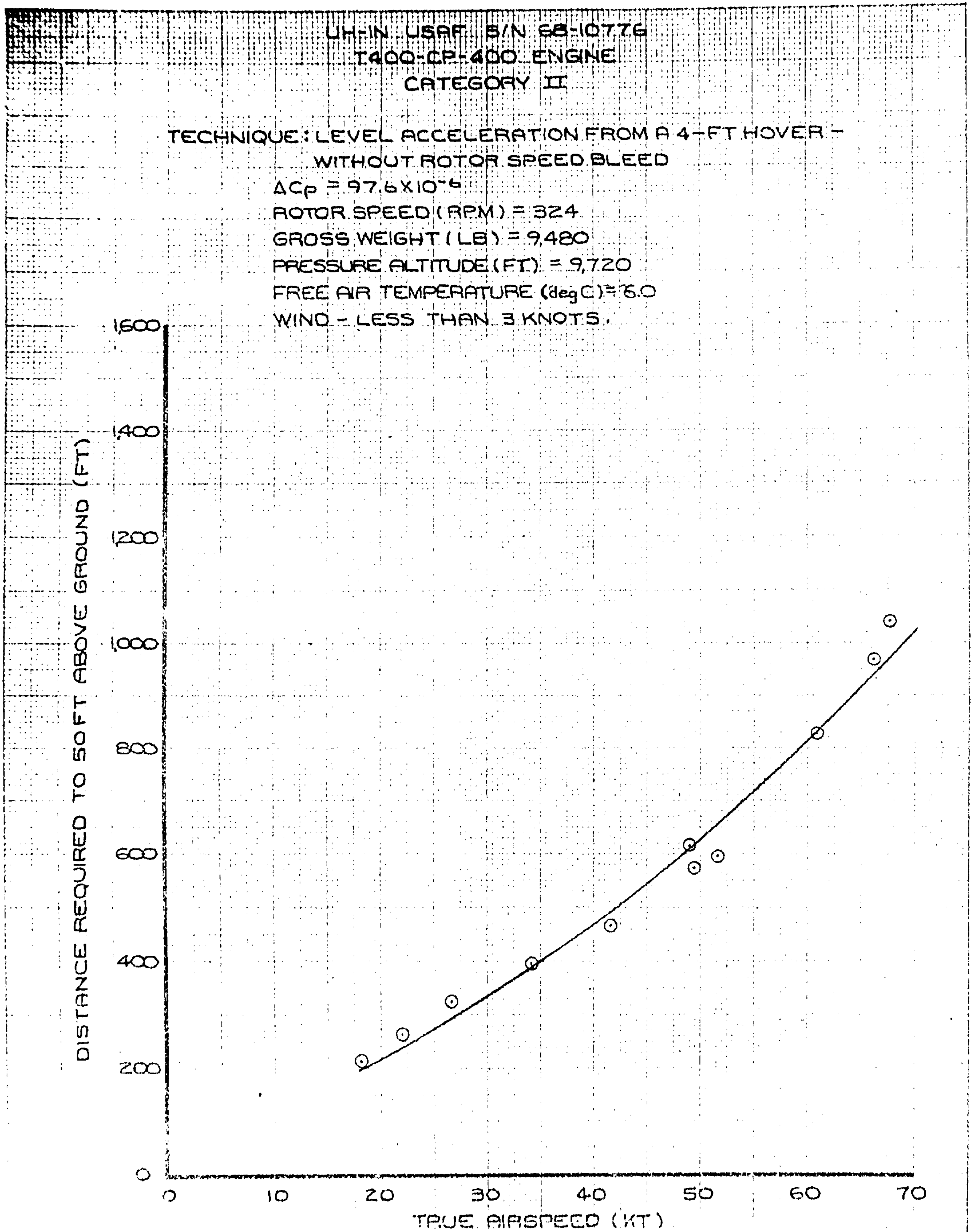


 FIGURE 21 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

TECHNIQUE
LEVEL ACCELERATION FROM A 4-FT HOVER -
WITH ROTOR SPEED BLEED

NOTE :
1. CURVES DERIVED FROM FIGURES 23 THROUGH 25
2. DO NOT EXTRAPOLATE THESE DATA

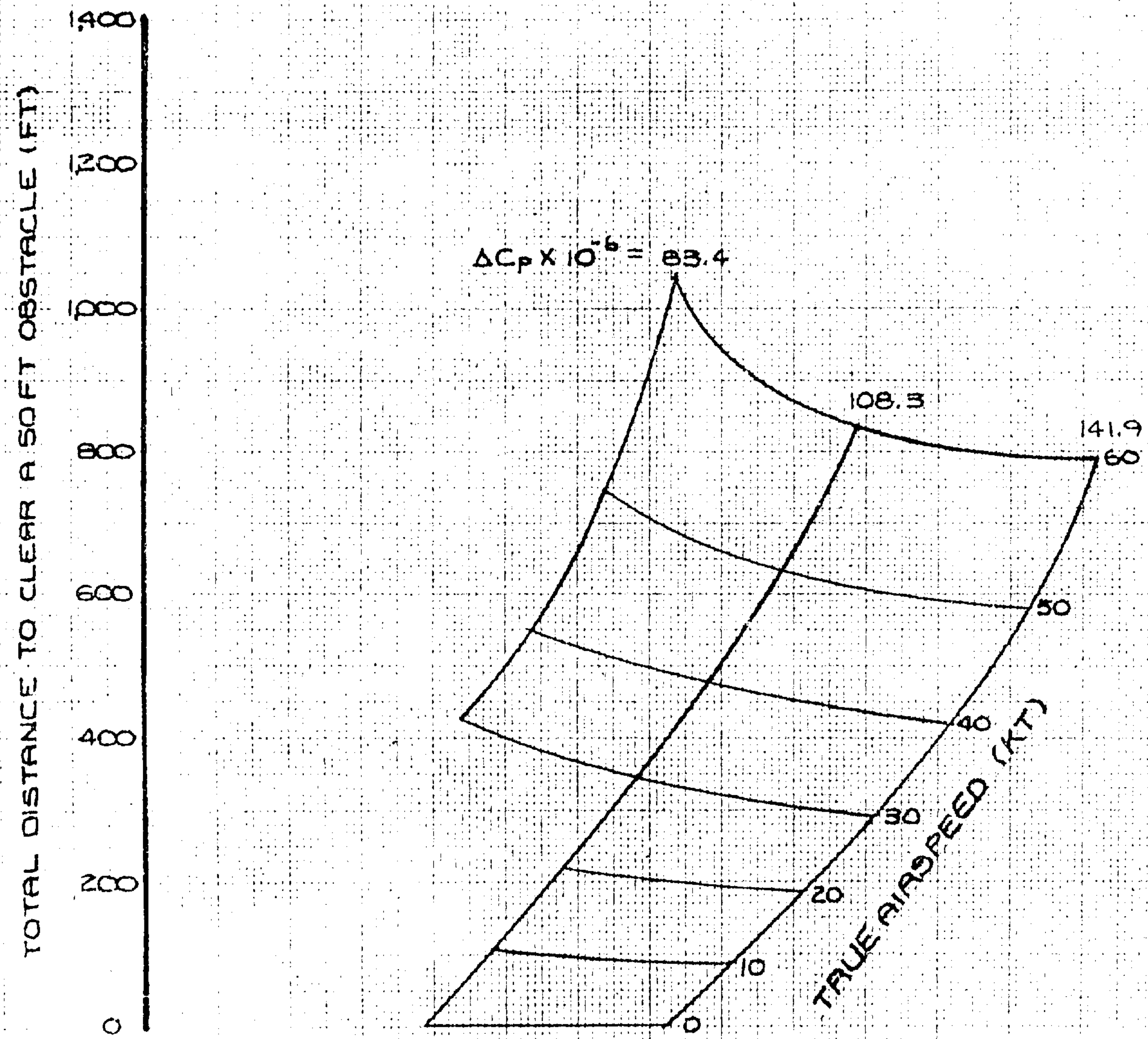


FIGURE 22 NONDIMENSIONAL TAKEOFF PERFORMANCE

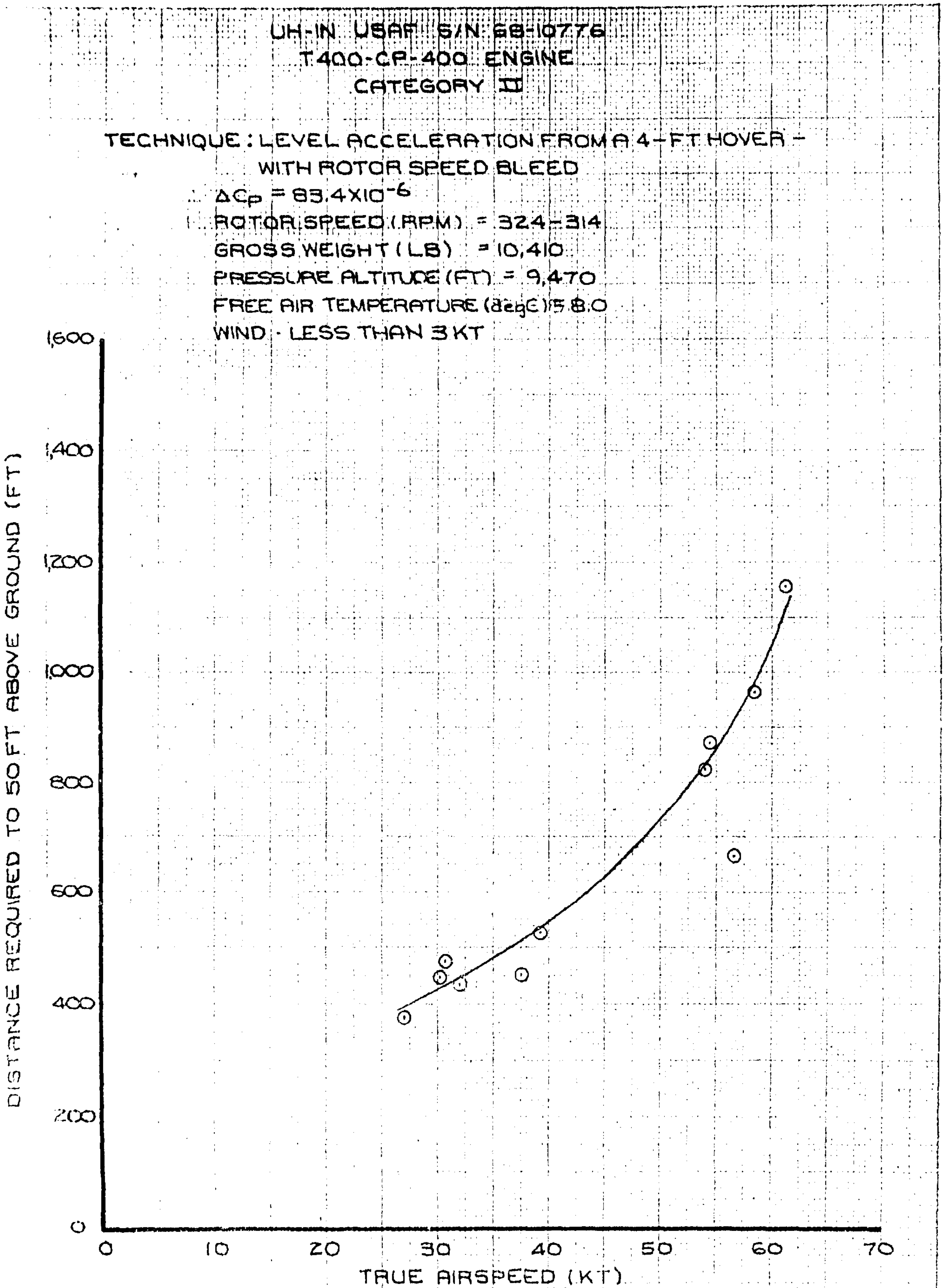


 FIGURE 23 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

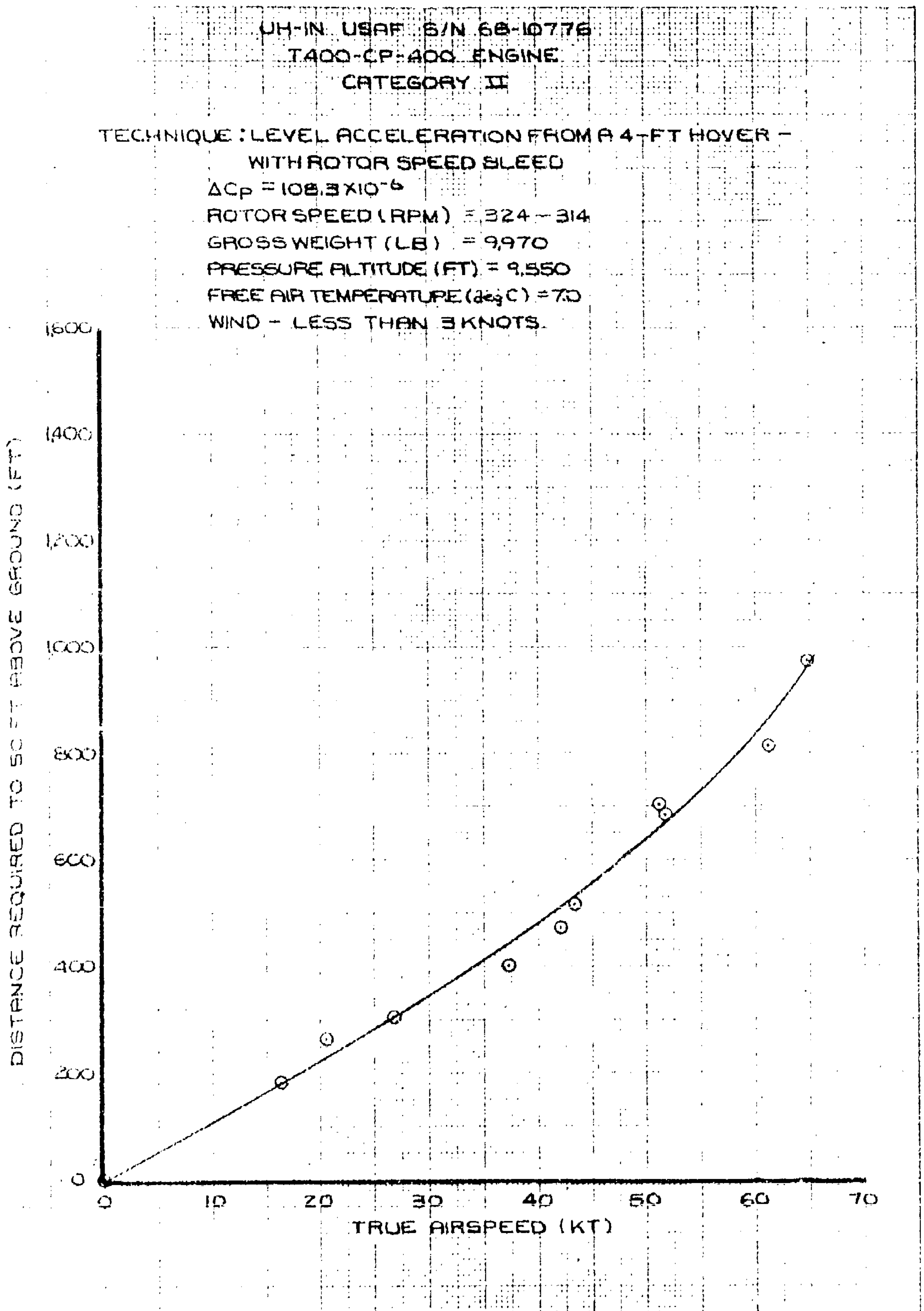


FIGURE 24 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

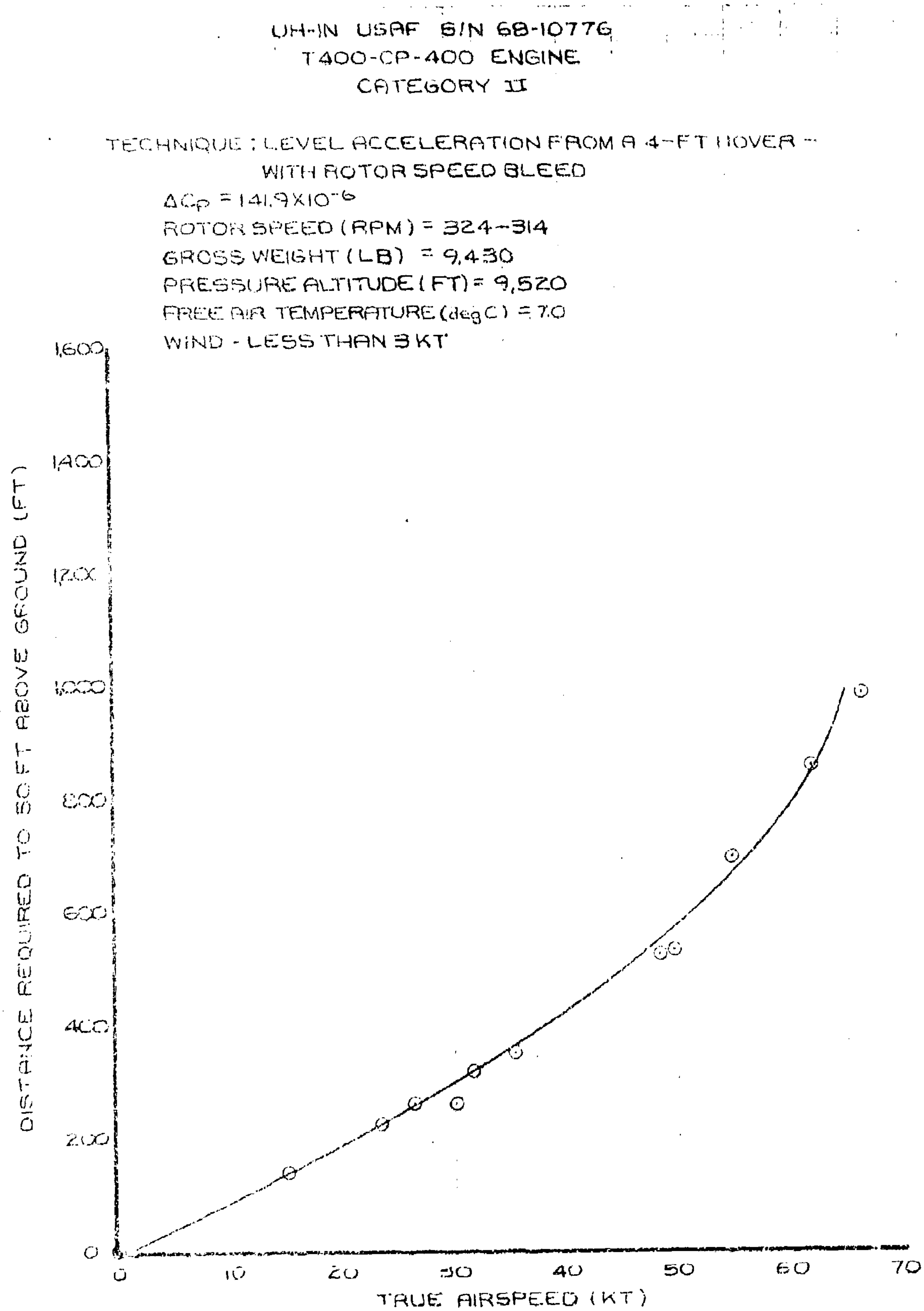


FIGURE 25 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50FT OBSTACLE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

TECHNIQUE
CLIMB AND ACCELERATION FROM LIGHT ON SKIDS – WITHOUT ROTOR SPEED BLEED

NOTE :
1. CURVES DERIVED FROM FIGURE 27 THROUGH 29
2. DO NOT EXTRAPOLATE THESE DATA
3. ΔC_p BASED ON POWER AVAILABLE LESS POWER REQUIRED TO HOVER AT 4 FT SKID HEIGHT

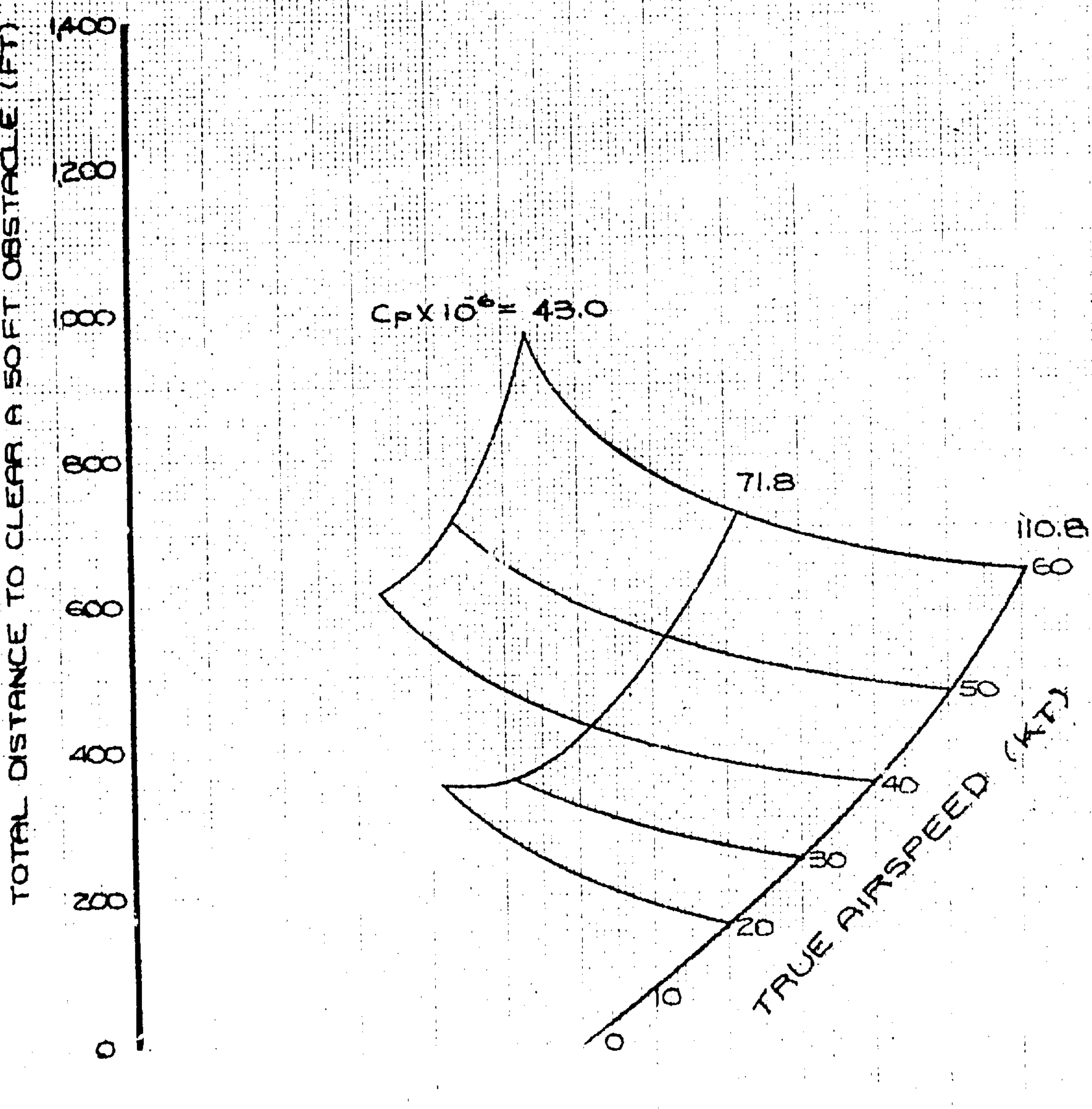


FIGURE 26 NONDIMENSIONAL TAKEOFF PERFORMANCE

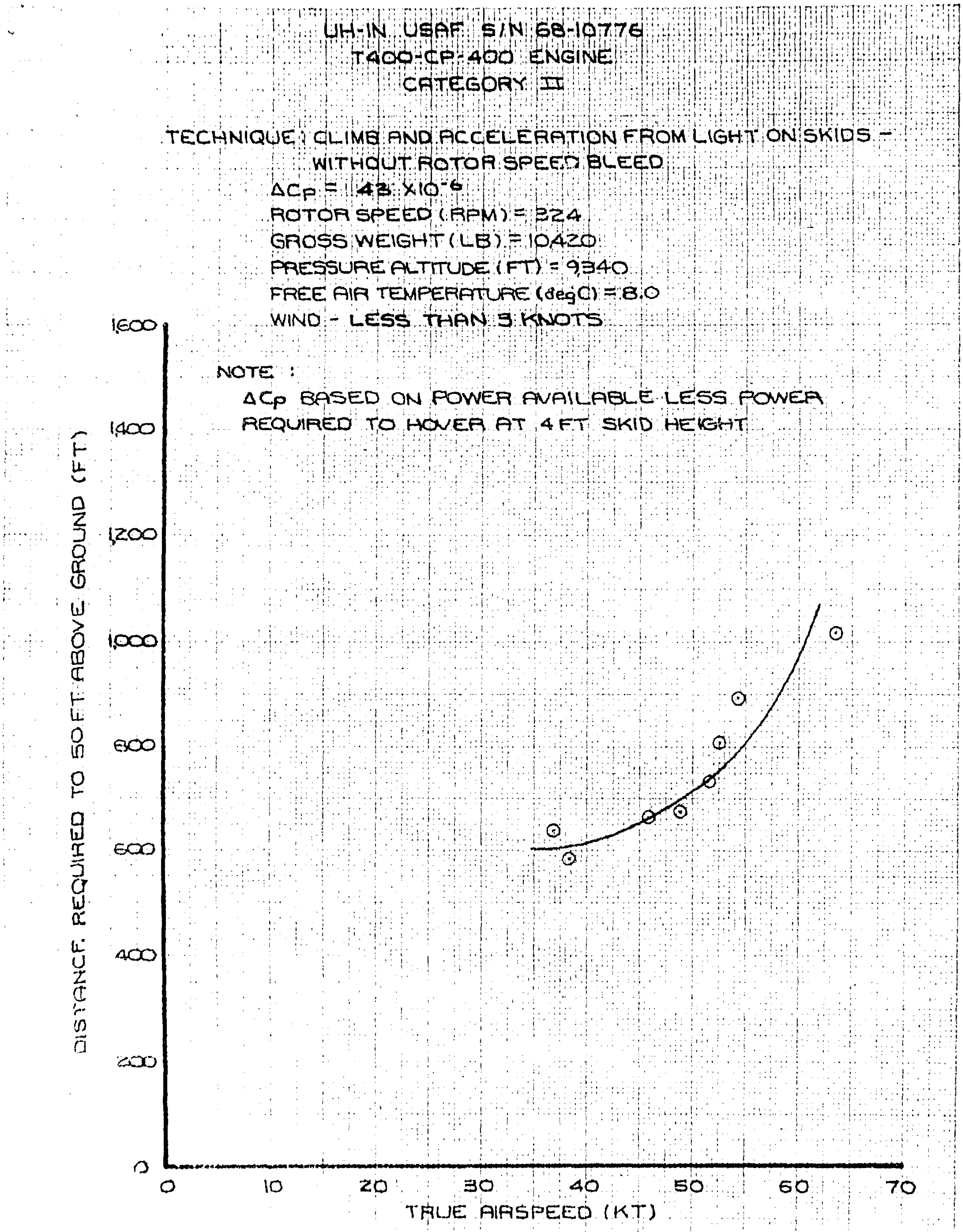


FIGURE 27 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

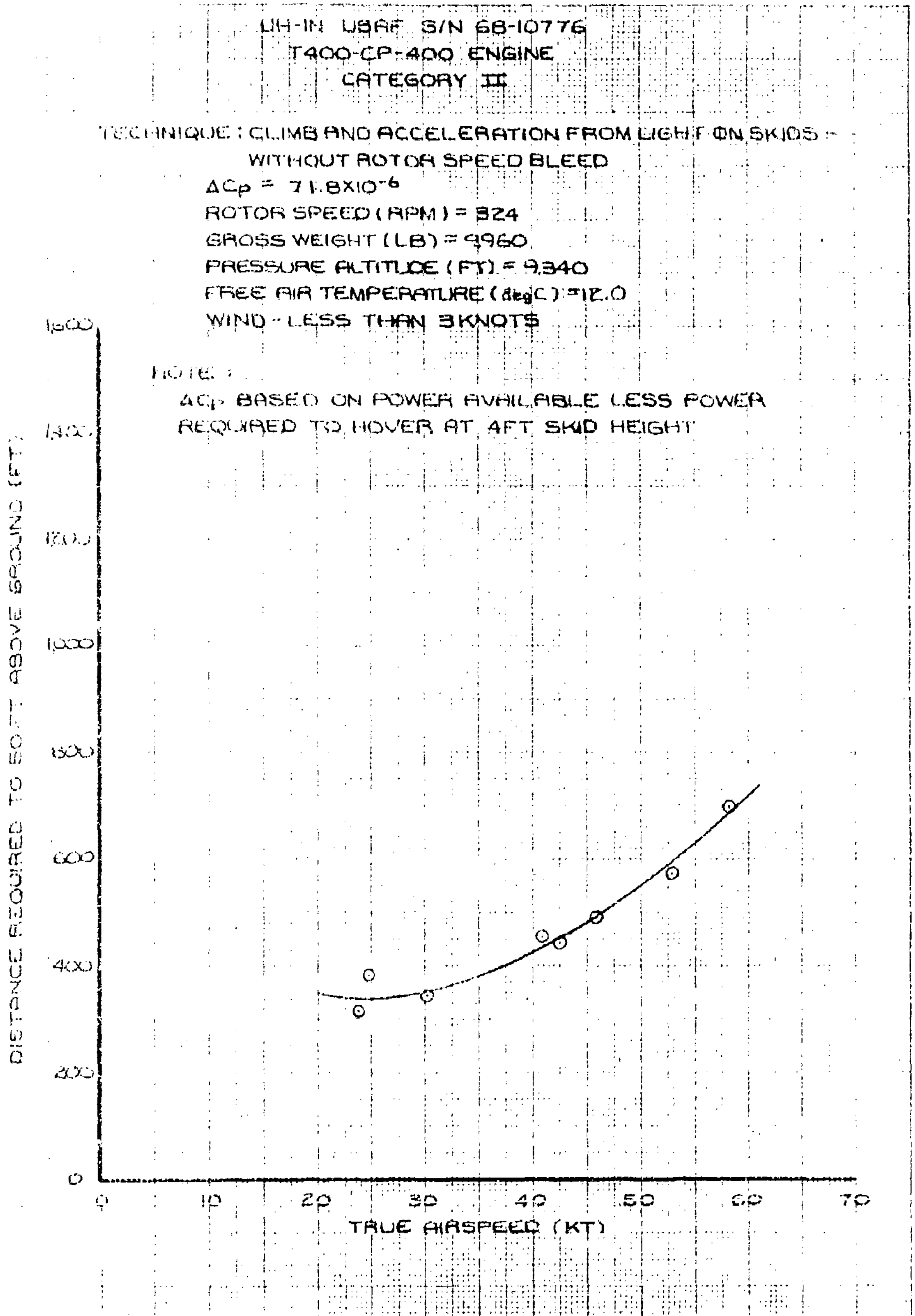
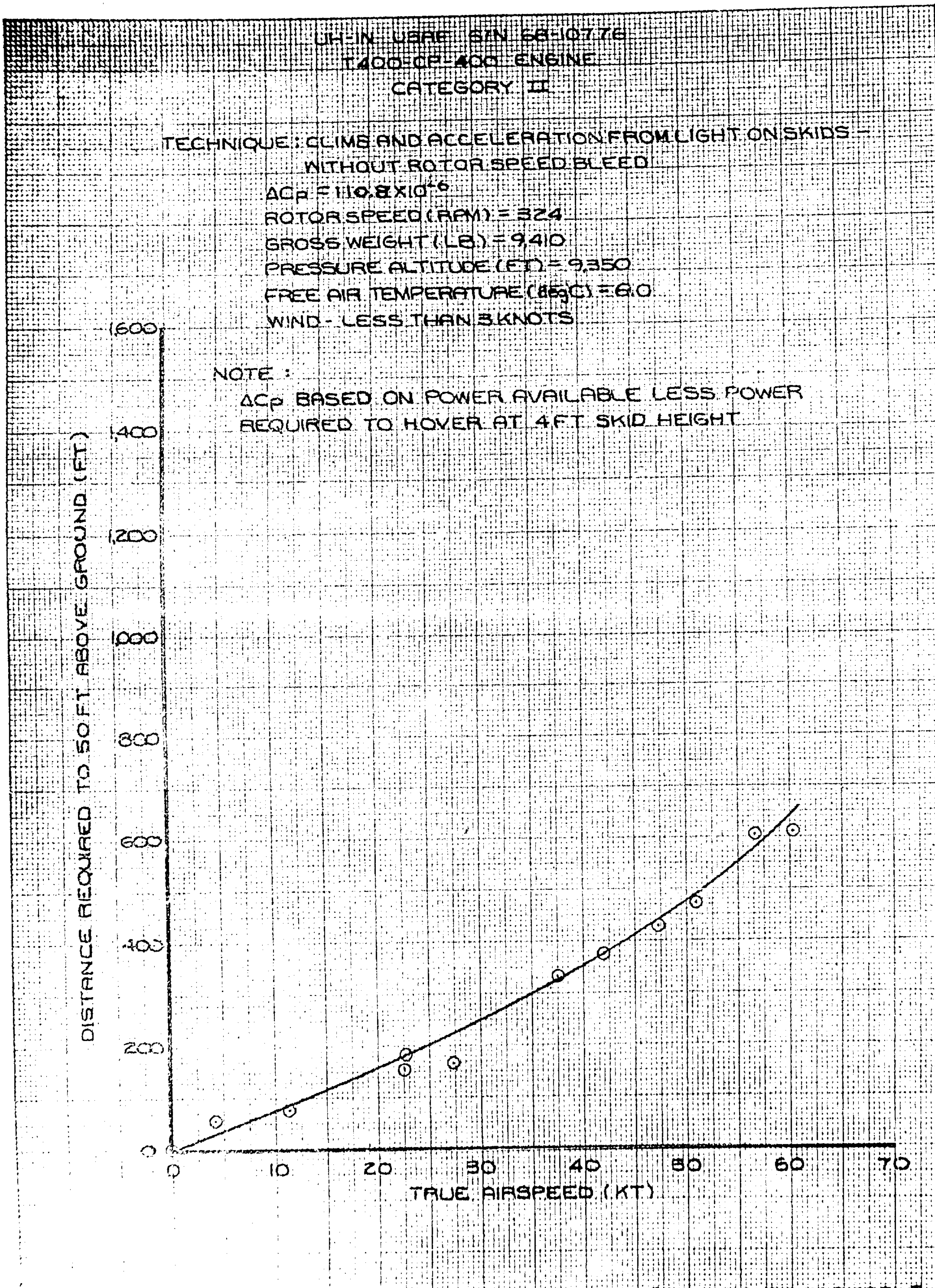


FIGURE 28 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE



TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

TECHNIQUE
CLIMB AND ACCELERATION FROM LIGHT ON SKIDS - WITH ROTOR SPEED BLEED

NOTE :
1. CURVES DERIVED FROM FIGURES 31 THROUGH 33
2. DO NOT EXTRAPOLATE THESE DATA
3. ΔC_P BASED ON POWER AVAILABLE LESS POWER REQUIRED TO HOVER AT 4 FT SKID HEIGHT

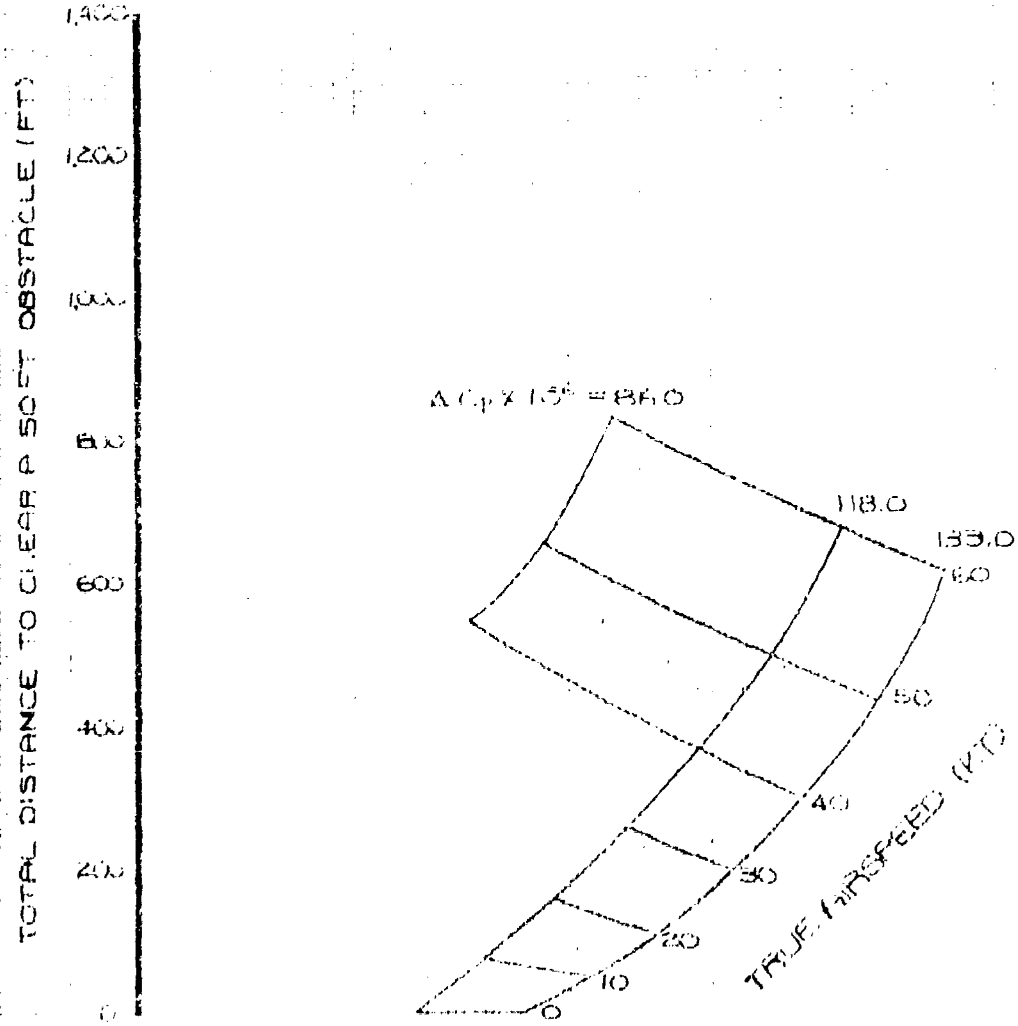


FIGURE 35 NONDIMENSIONAL TAKEOFF PERFORMANCE

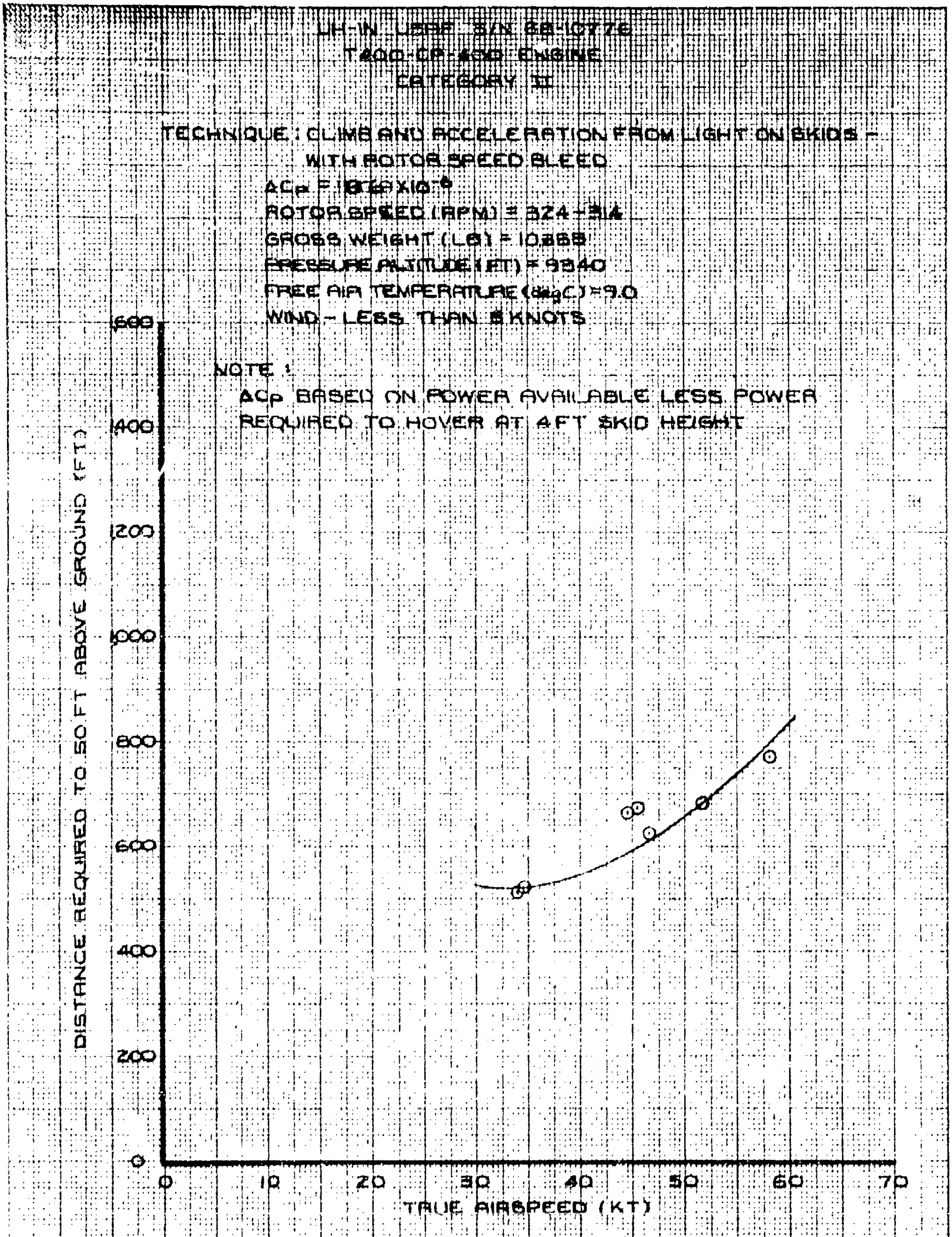


FIGURE 31 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

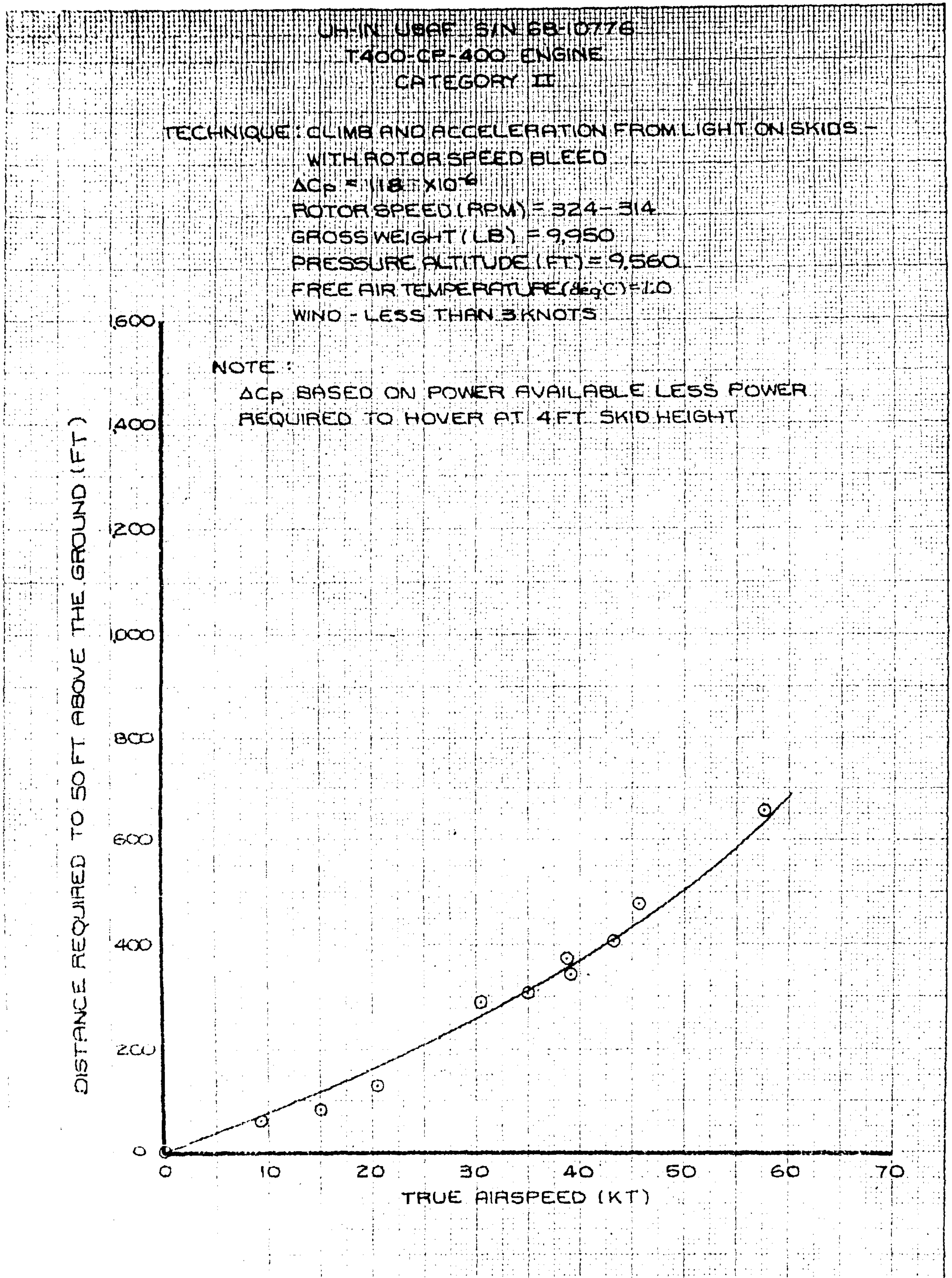


FIGURE 32 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

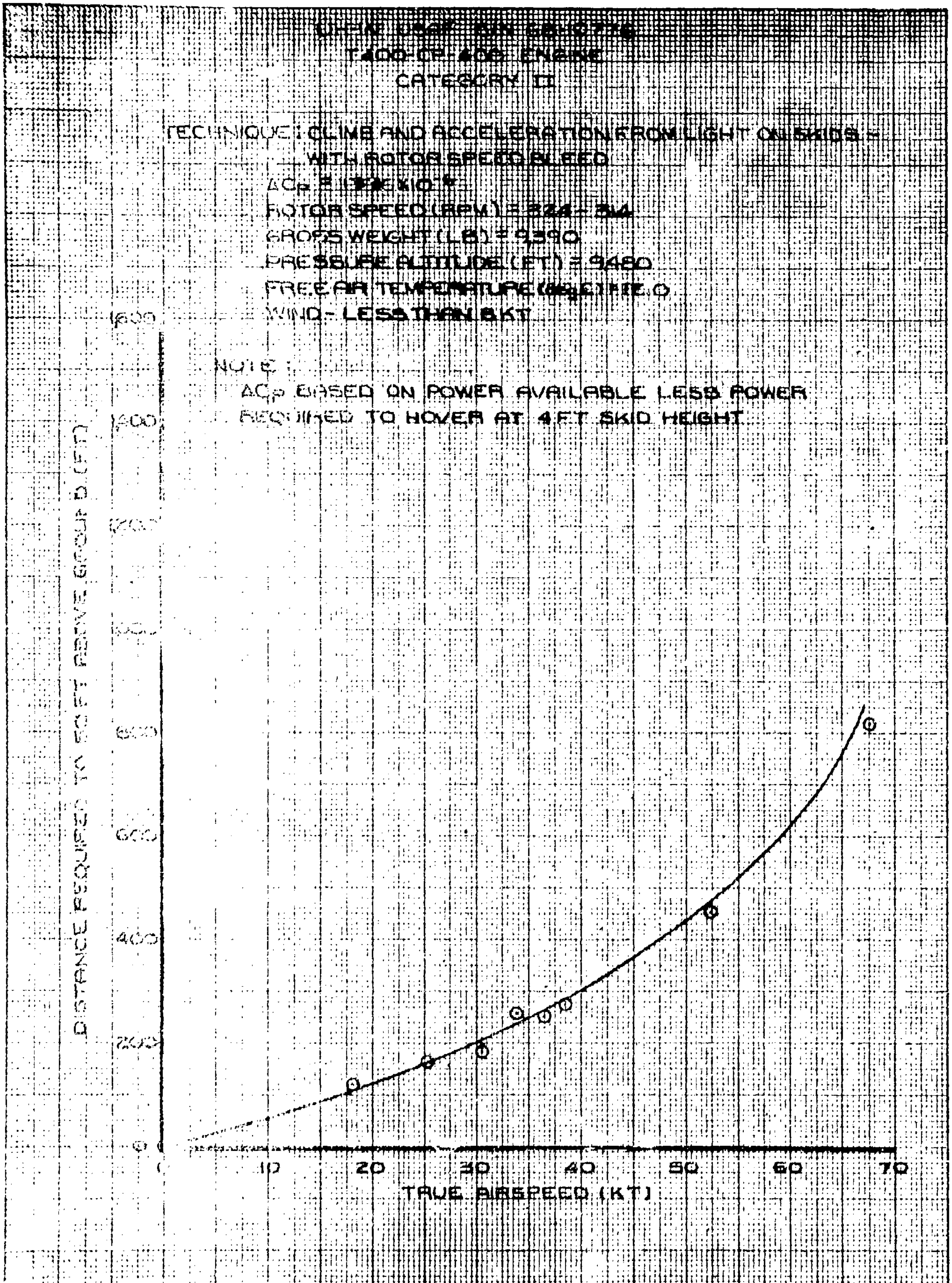


FIGURE 33 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

TECHNIQUE
LEVEL ACCELERATION FROM A 15-FT HOVER -
WITHOUT ROTOR SPEED BLEED

NOTE:
1. CURVES DERIVED FROM FIGURES 35 THROUGH 37.
2. DO NOT EXTRAPOLATE THESE DATA.

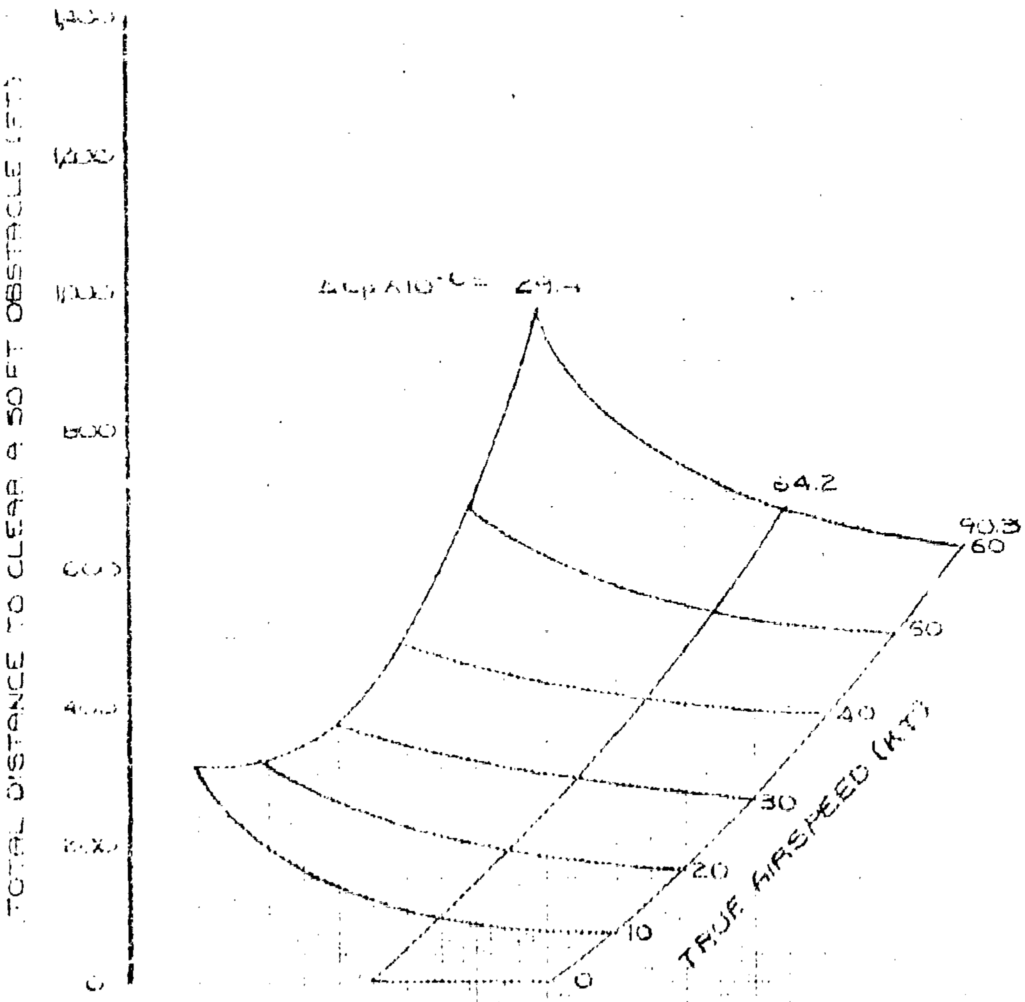


FIGURE 34 NONDIMENSIONAL TAKEOFF PERFORMANCE

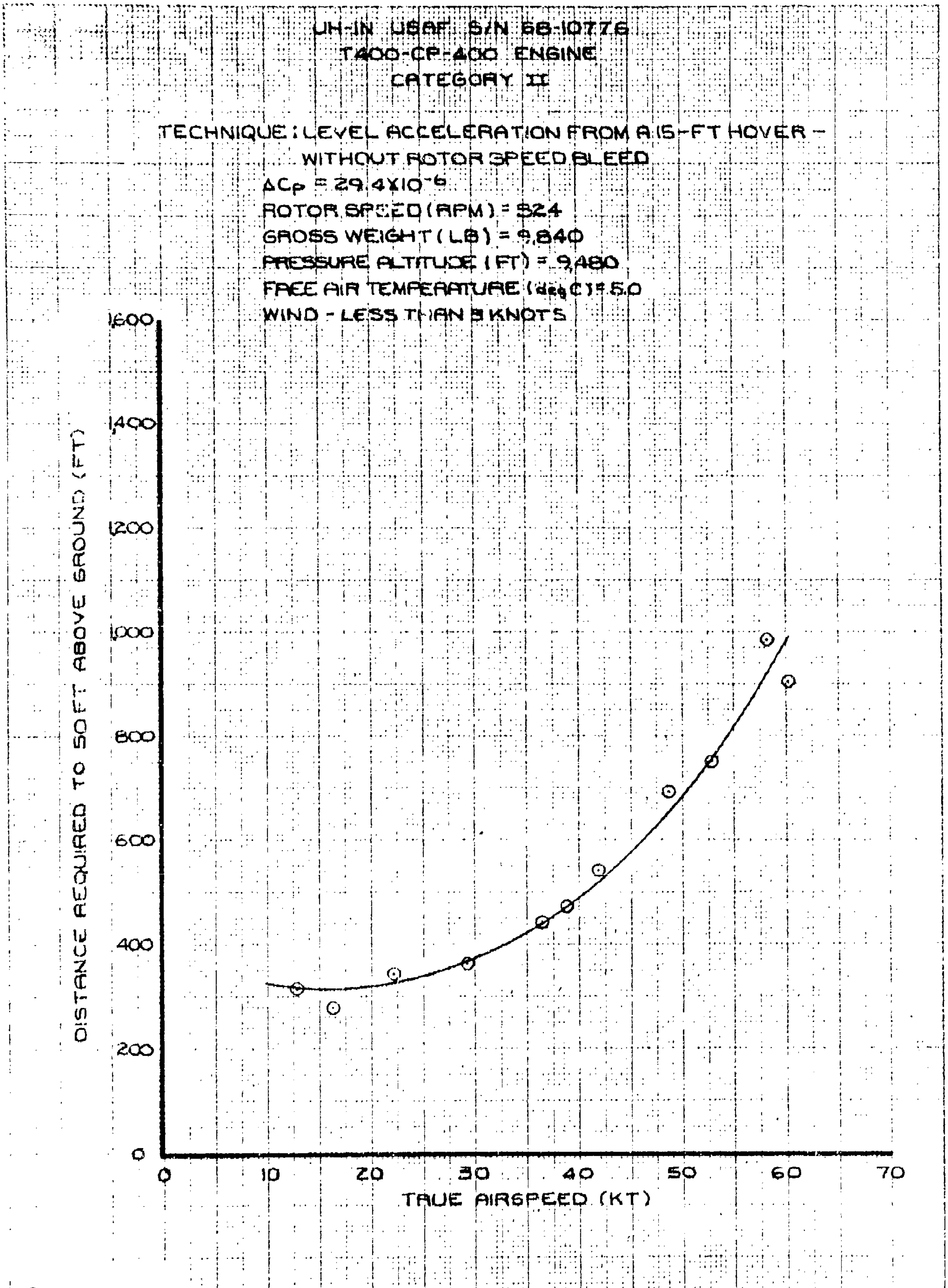


FIGURE 35 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

TECHNIQUE : LEVEL ACCELERATION FROM A 15-FT HOVER – WITHOUT ROTOR SPEED BLEED

$\Delta C_P = 64.2 \times 10^{-6}$
ROTOR SPEED (RPM) = 324
GROSS WEIGHT (LB) = 9,370
PRESSURE ALTITUDE (FT) = 9,490
FREE AIR TEMPERATURE (deg C) = 3.0
WIND - LESS THAN 3 KNOTS

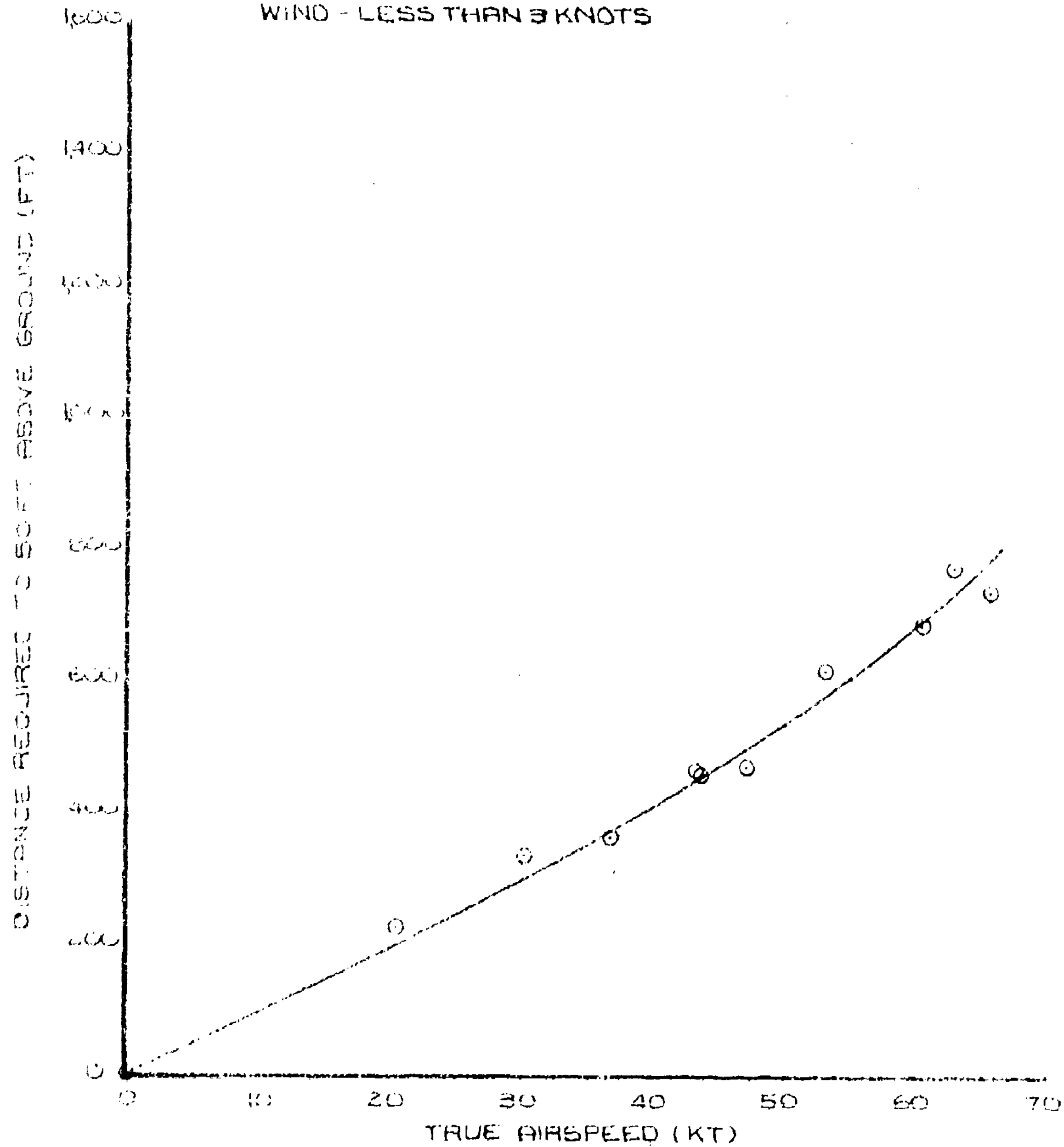


FIGURE 36. TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

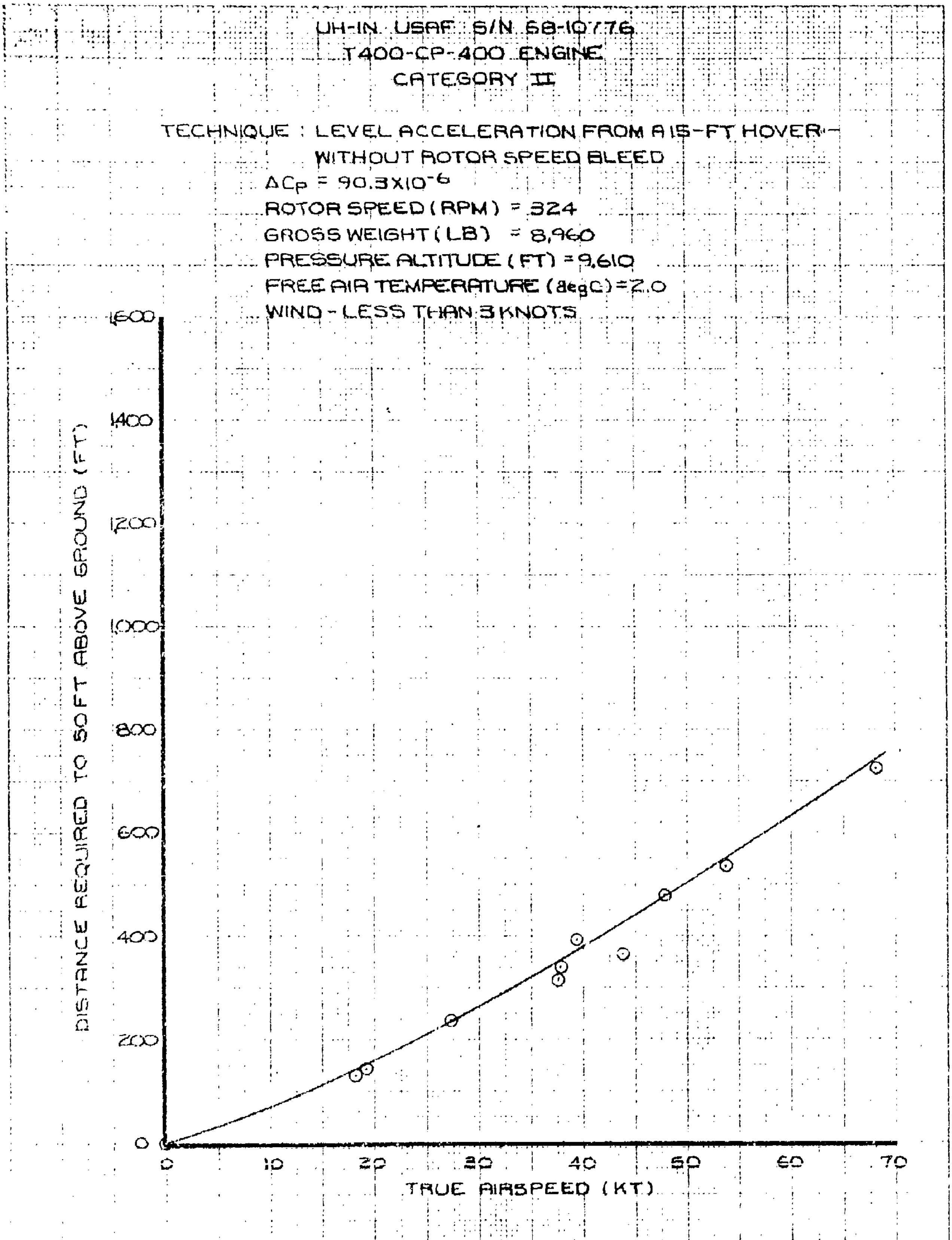


 FIGURE 37 TAKEOFF DISTANCE REQUIRED TO CLEAR A 50-FT OBSTACLE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SYM	GROSS WT (LB)	PRESS. ALT (FT)	OAT (°C)	ROTOR SPEED (RPM)	SHP	TORQUE (PCT)
Q	8,610	5,000	8.0	314	881	71
O	8,610	5,000	4.0	314	1,108	88
△	8,650	10,000	-3.0	314	1,100	88
□	8,440	14,000	-10.0	314	1,104	88
□	8,550	14,000	-7.0	314	1,084	88

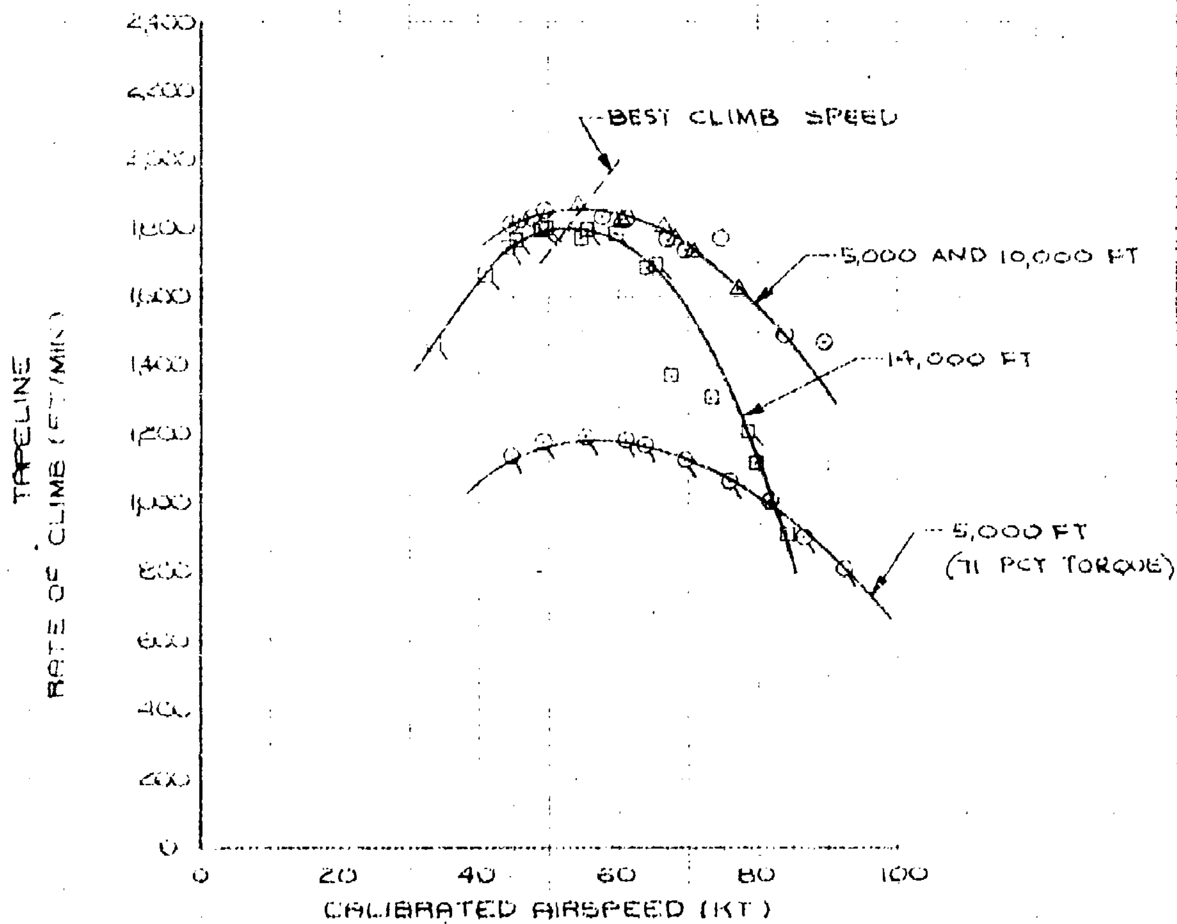


FIGURE 38 SAWTOOTH CLIMB PERFORMANCE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SYM	GROSS WT. (LB)	PRESS. ALT. (FT)	OAT (°C)	ROTOR SPEED (RPM)	SHP	TORQUE (PCT)
Q	9,970	5,000	2.0	314	894	71
O	10,080	5,000	3.0	314	1,103	88
△	10,140	10,000	-13.0	314	1,107	88

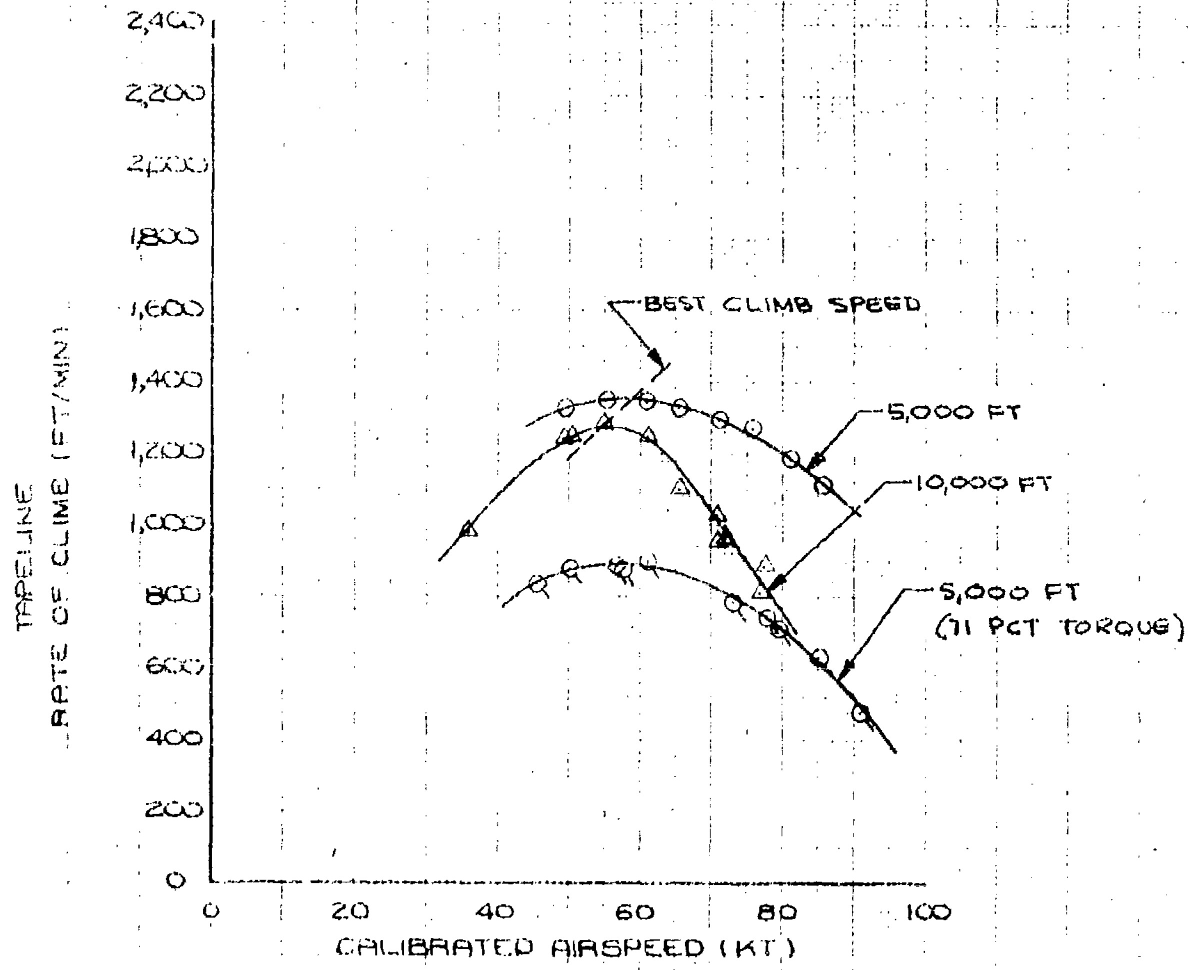


FIGURE 39 SAWTOOTH CLIMB PERFORMANCE

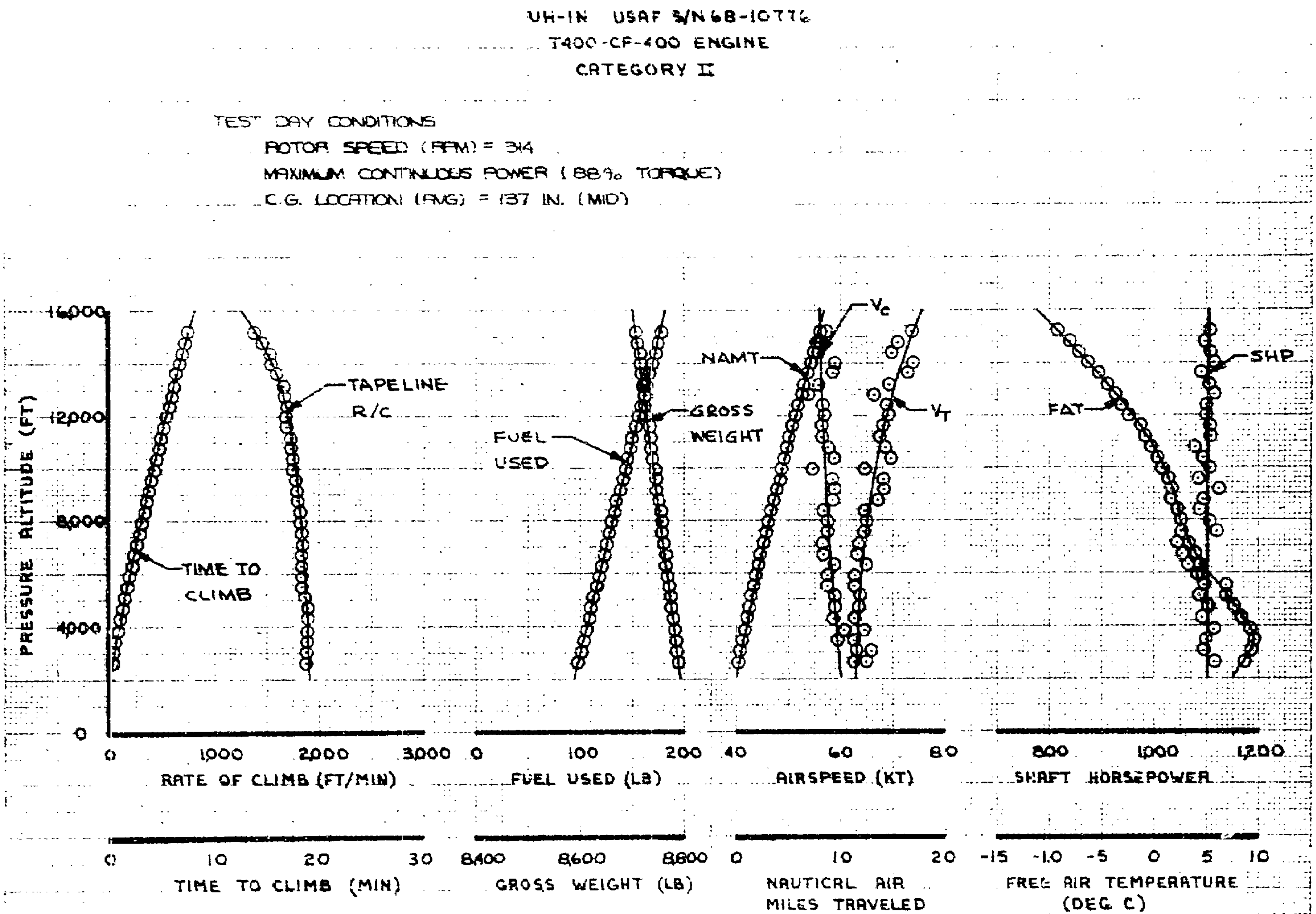


FIGURE 40 CONTINUOUS CLIMB PERFORMANCE

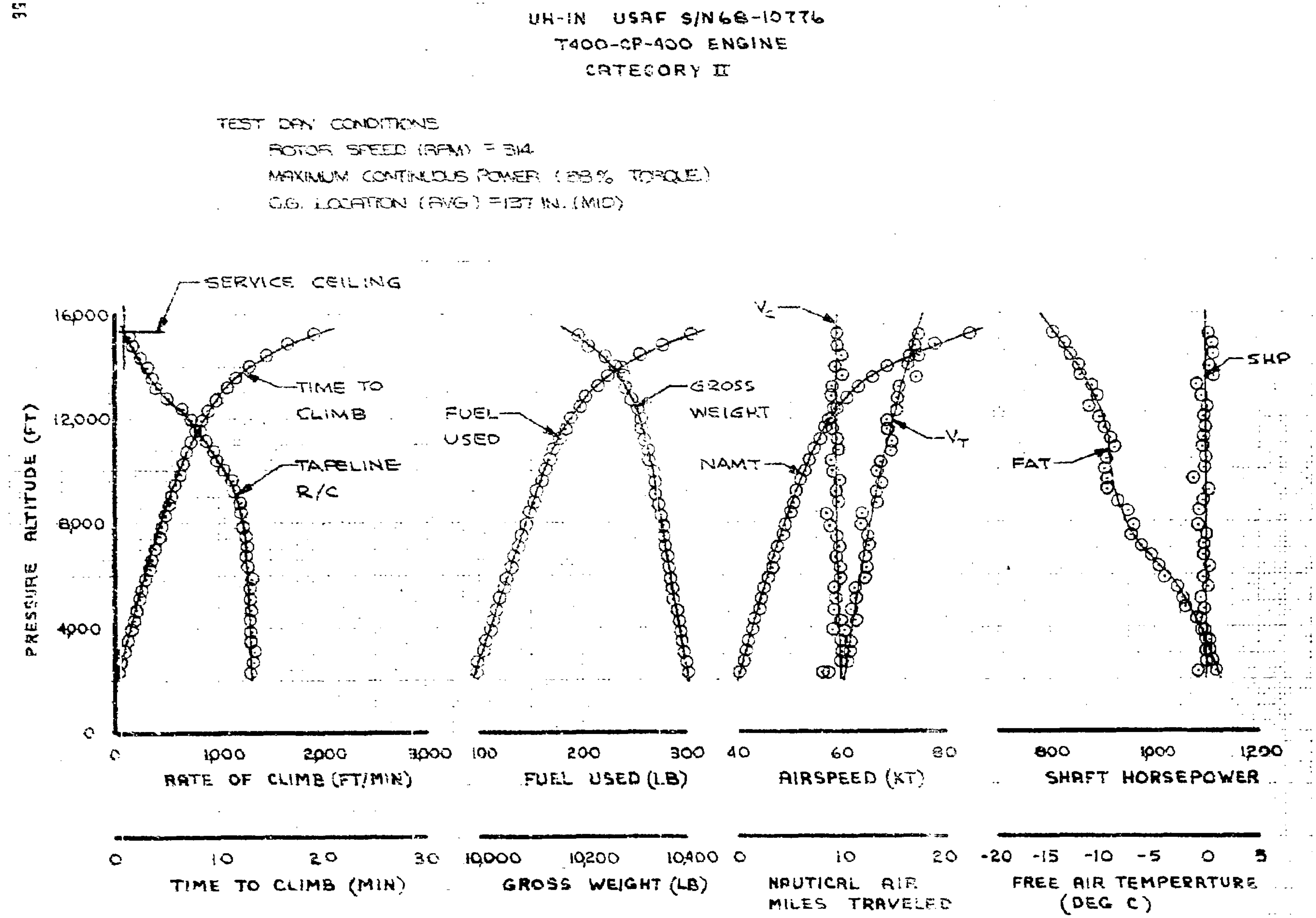


FIGURE 41 CONTINUOUS CLIMB PERFORMANCE

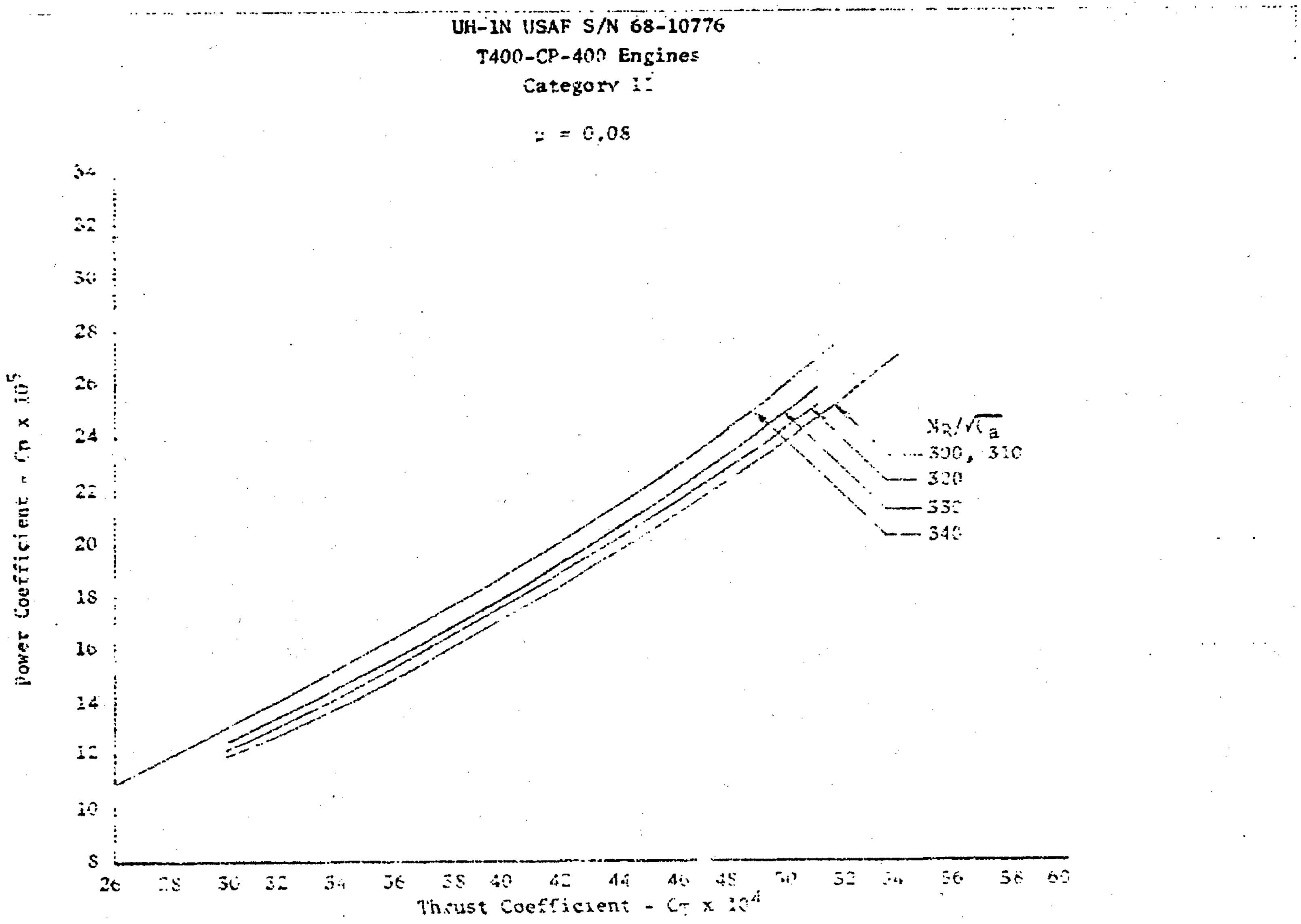


Figure 42 Nondimensional Level Flight Performance Summary

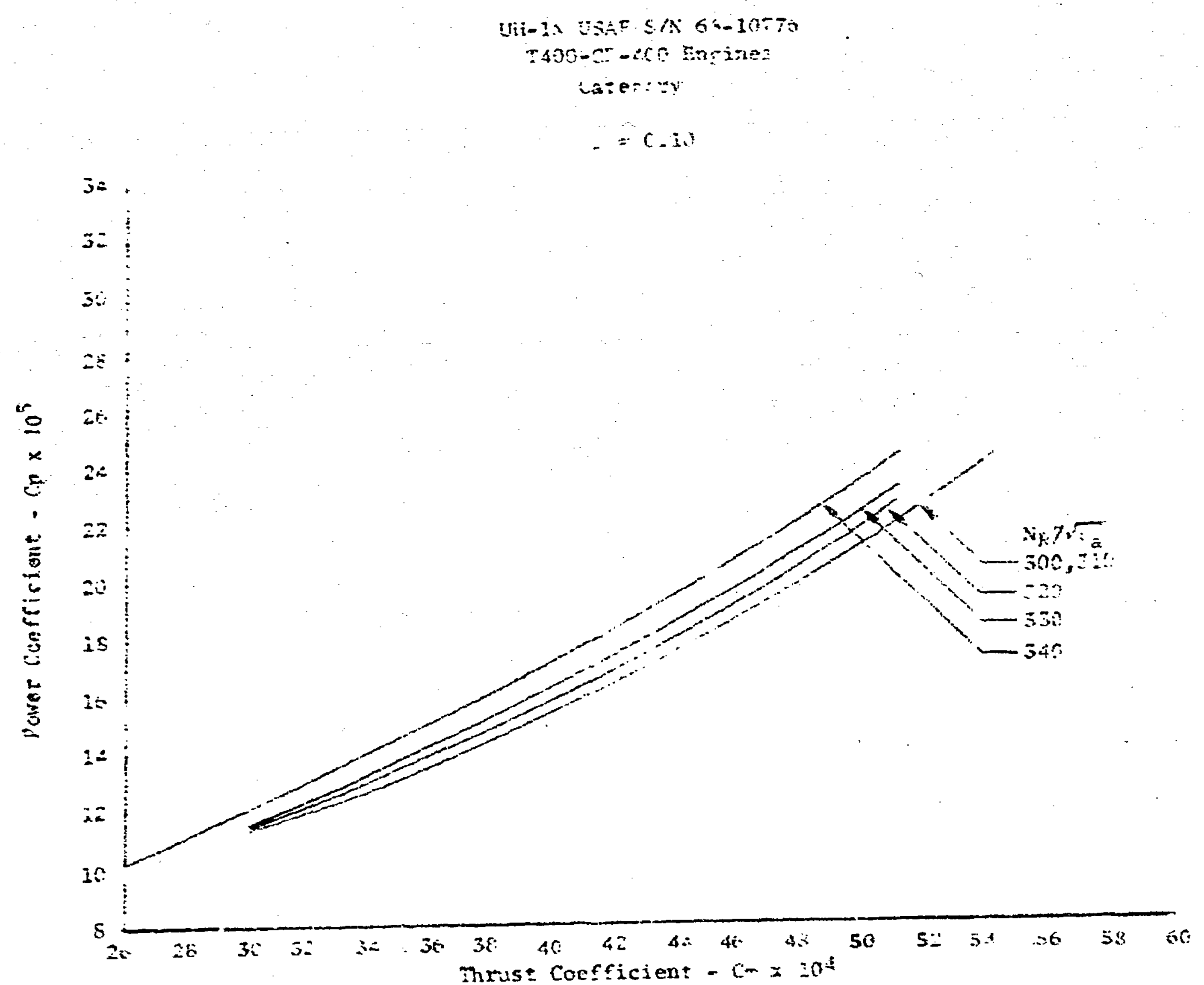


Figure 43 Nondimensional Level Flight Performance Summary

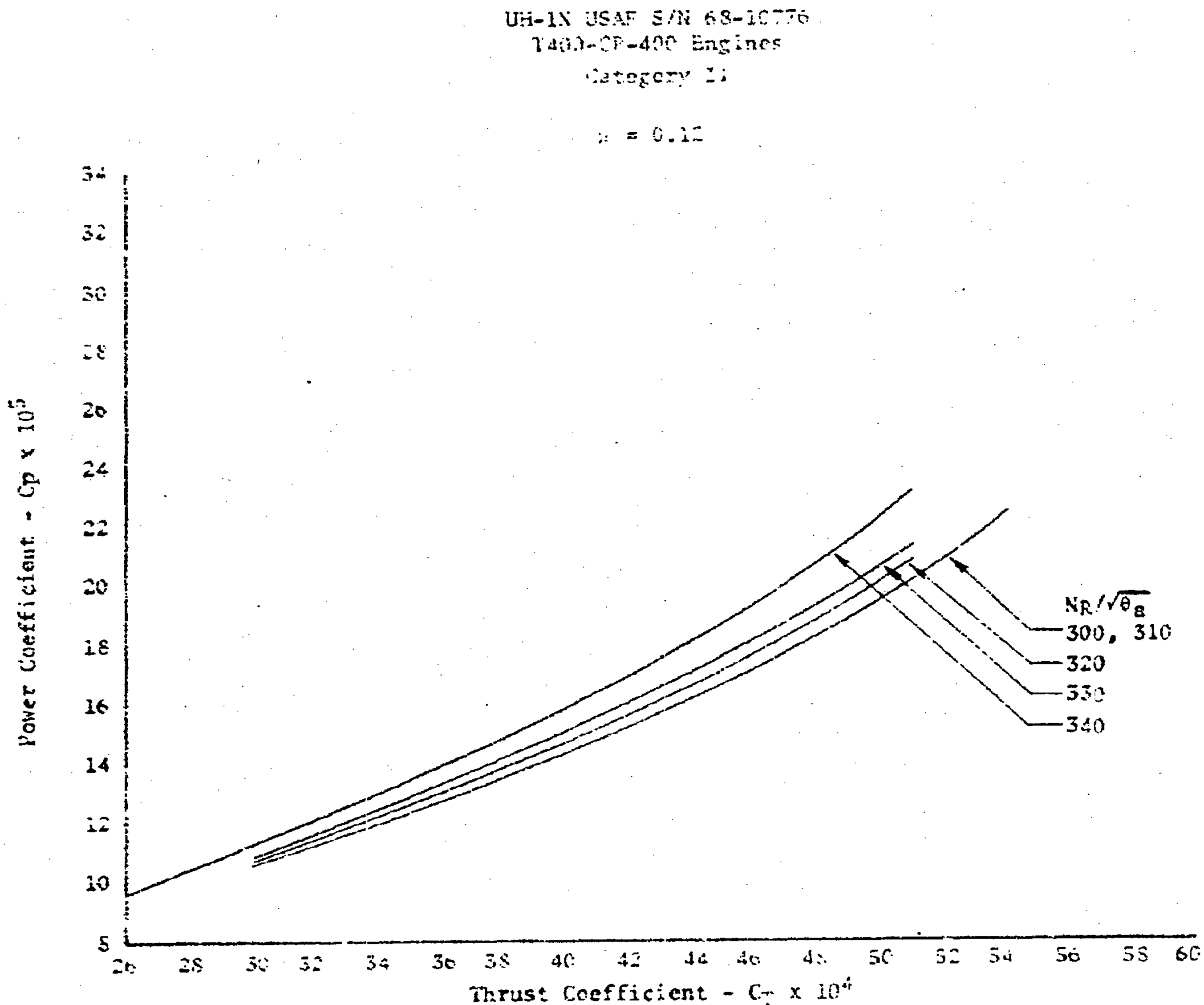


Figure 44 Nondimensional Level Flight Performance Summary

UH-1N USAF S/N 68-10776
T400-CP-400 Engines
Category II

$\mu = 0.14$

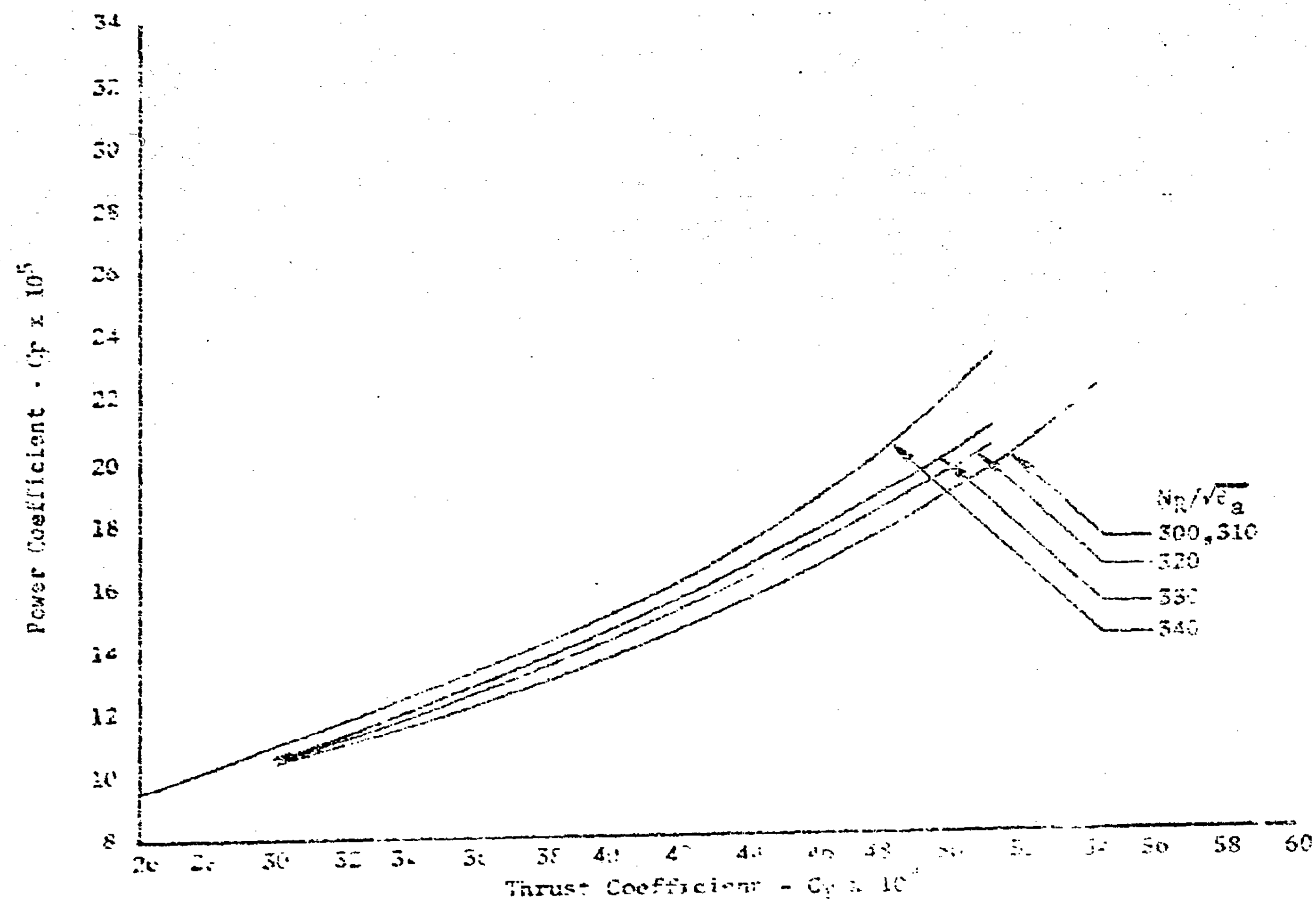


Figure 45 Nondimensional Level Flight Performance Summary

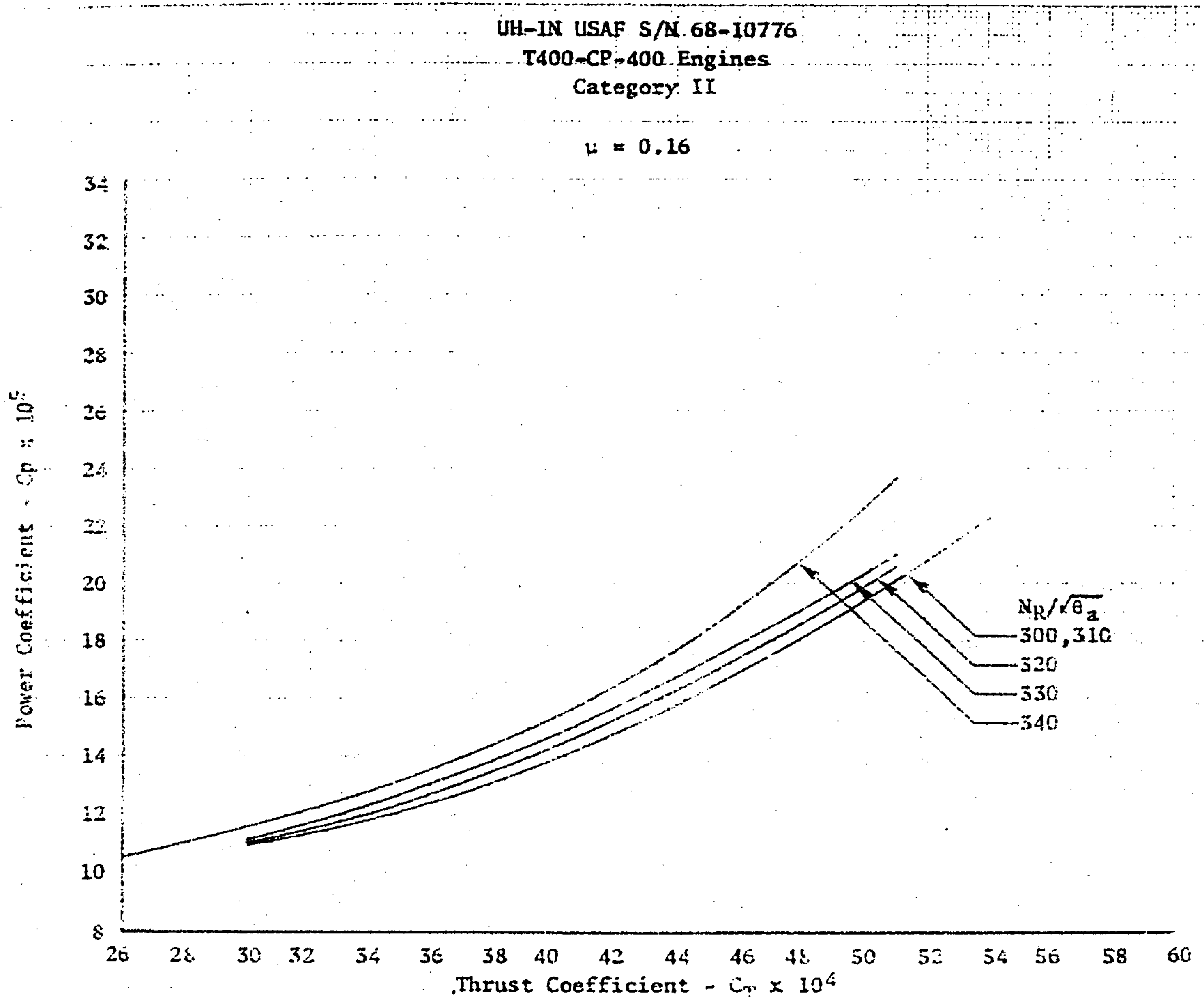


Figure 46 Nondimensional Level Flight Performance Summary

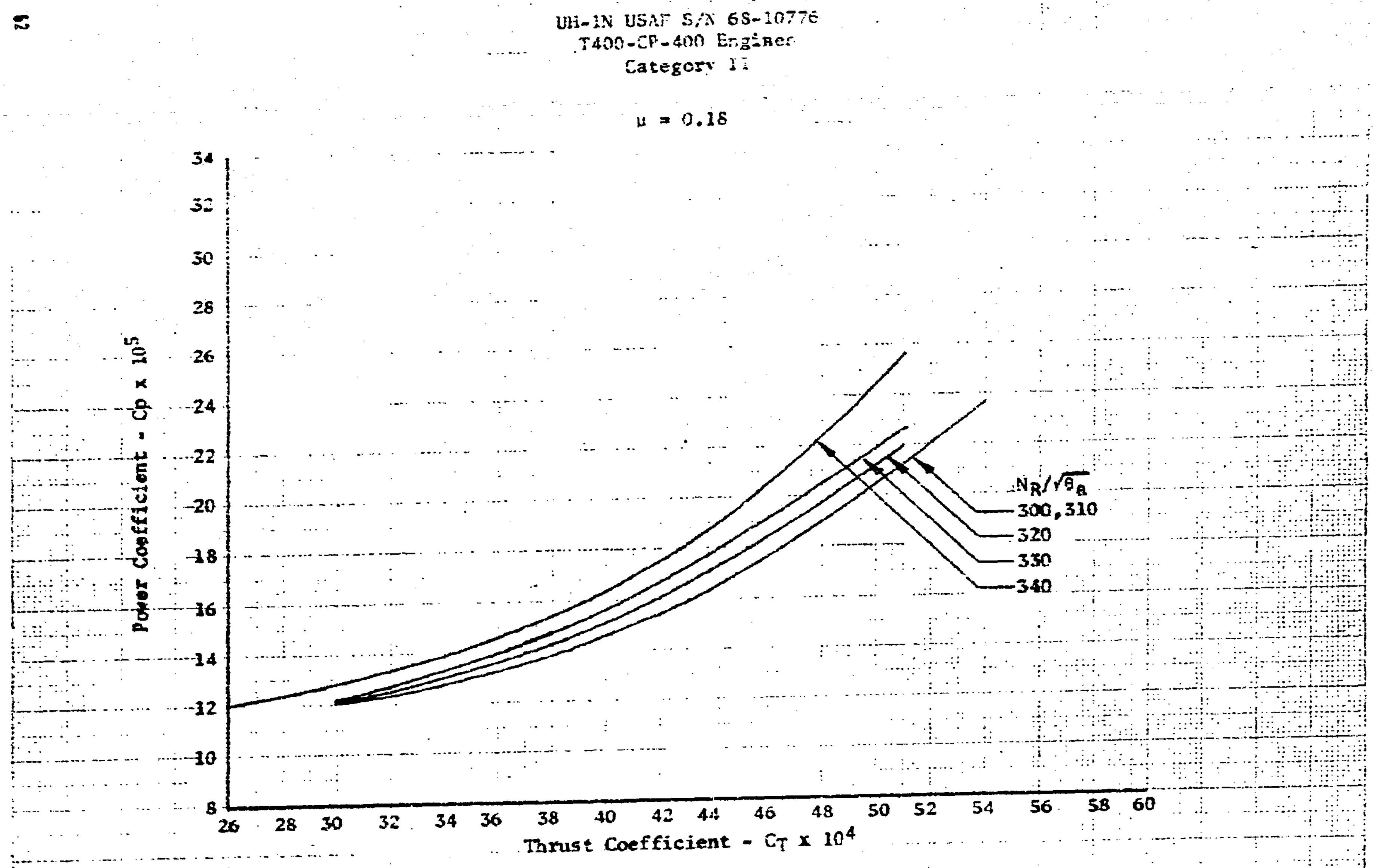


Figure 47 Nondimensional Level Flight Performance Summary

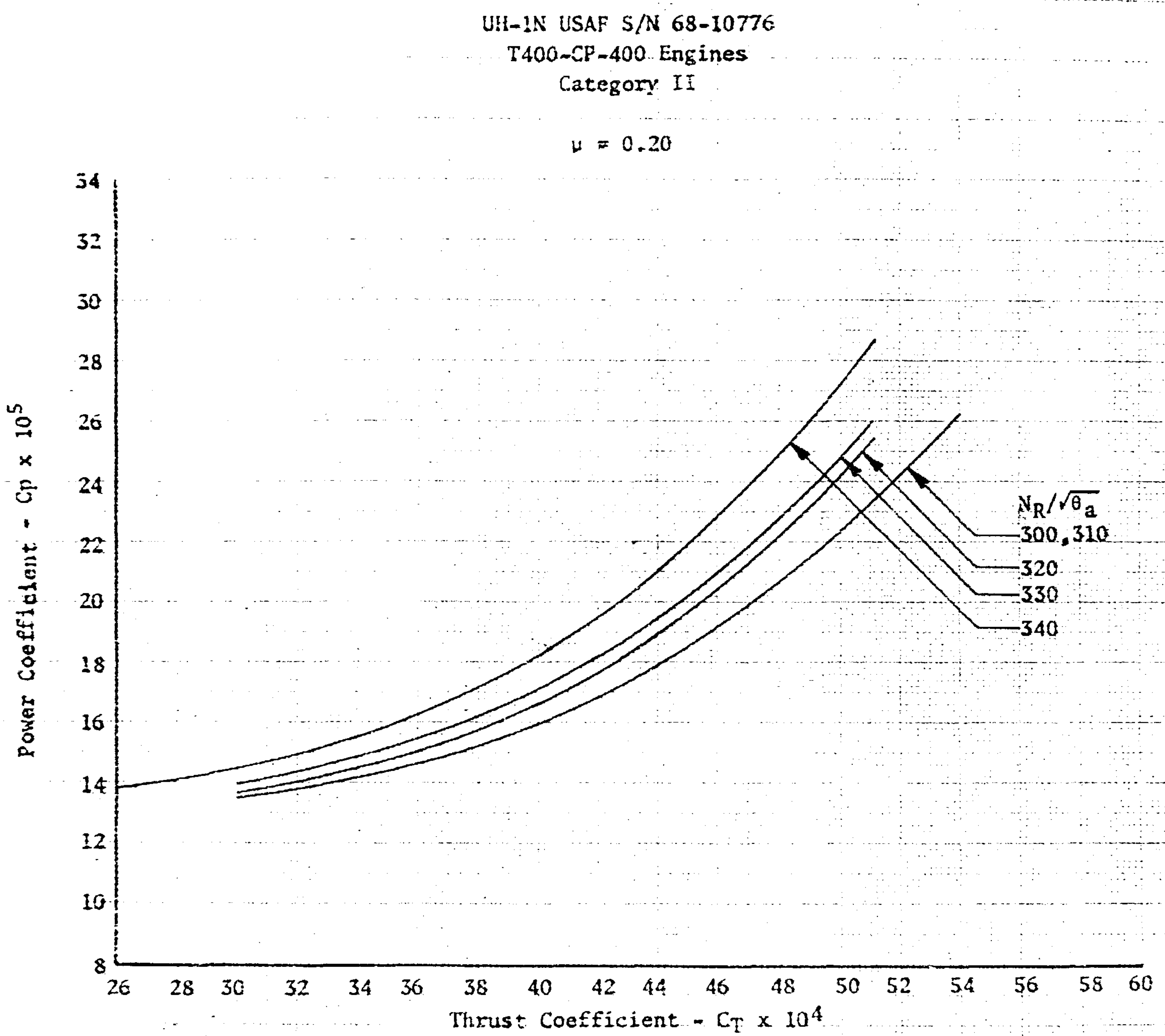


Figure 48 Nondimensional Level Flight Performance Summary

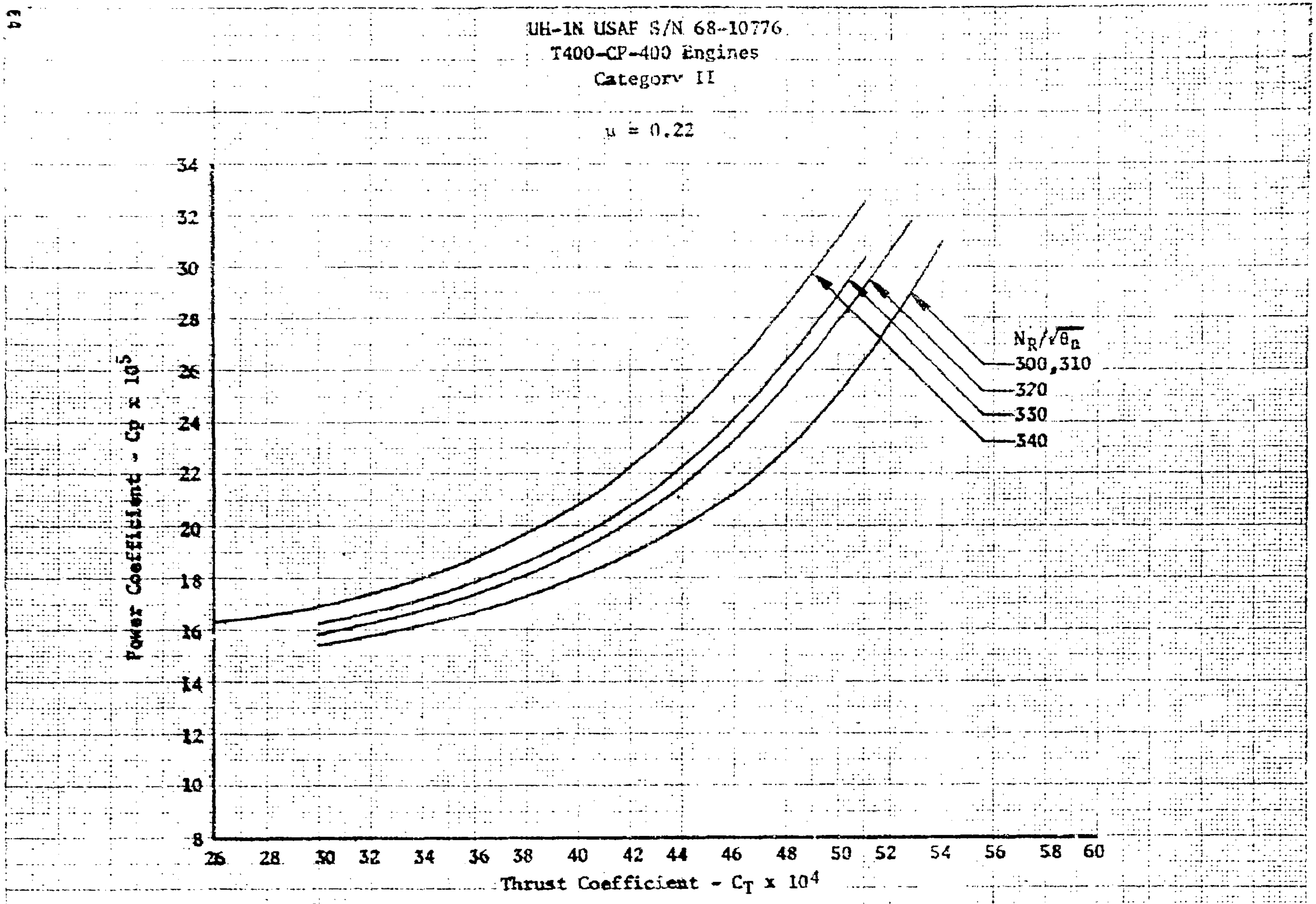


Figure 49 Nondimensional Level Flight Performance Summary

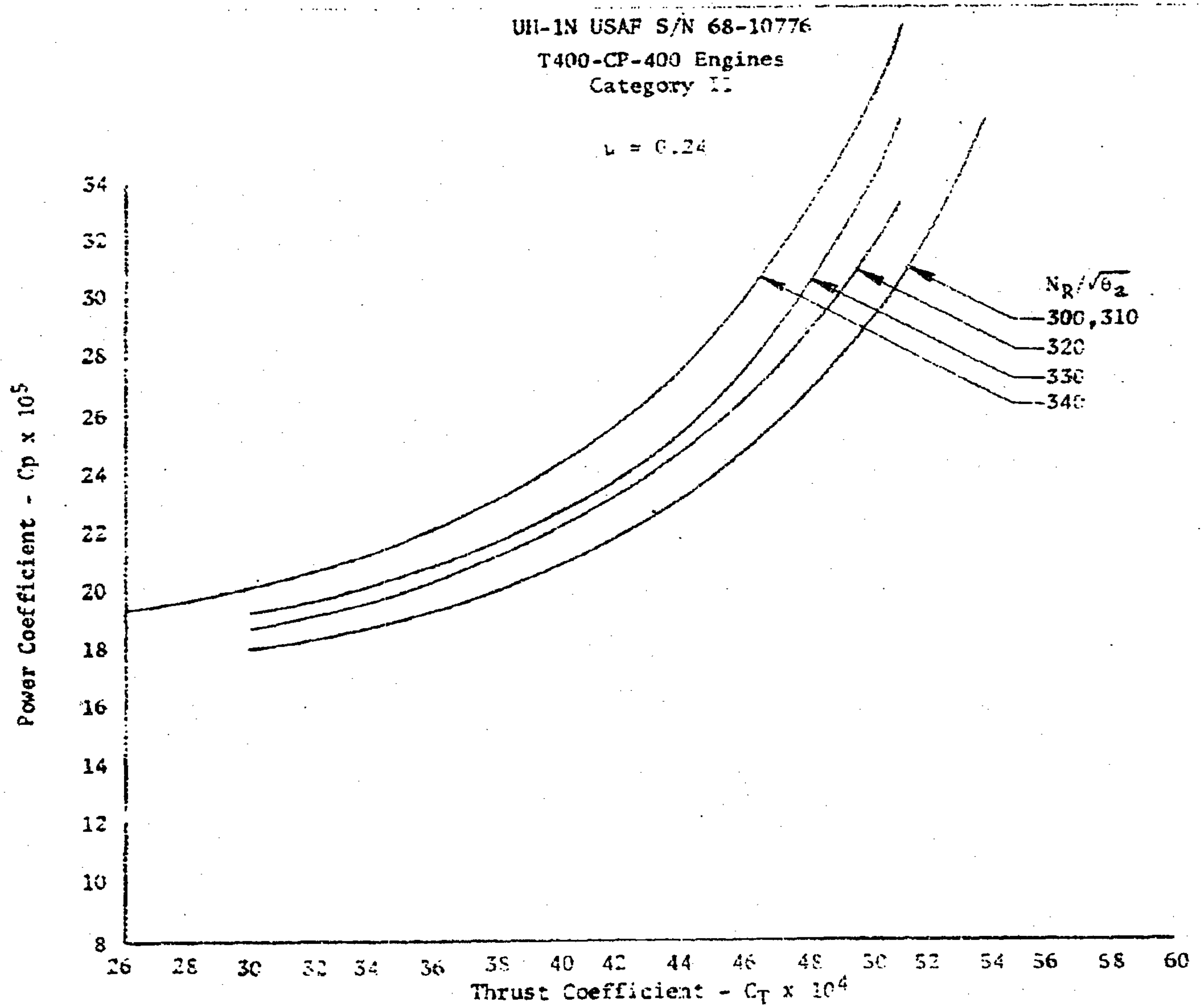


Figure 50 Nondimensional Level Flight Performance Summary

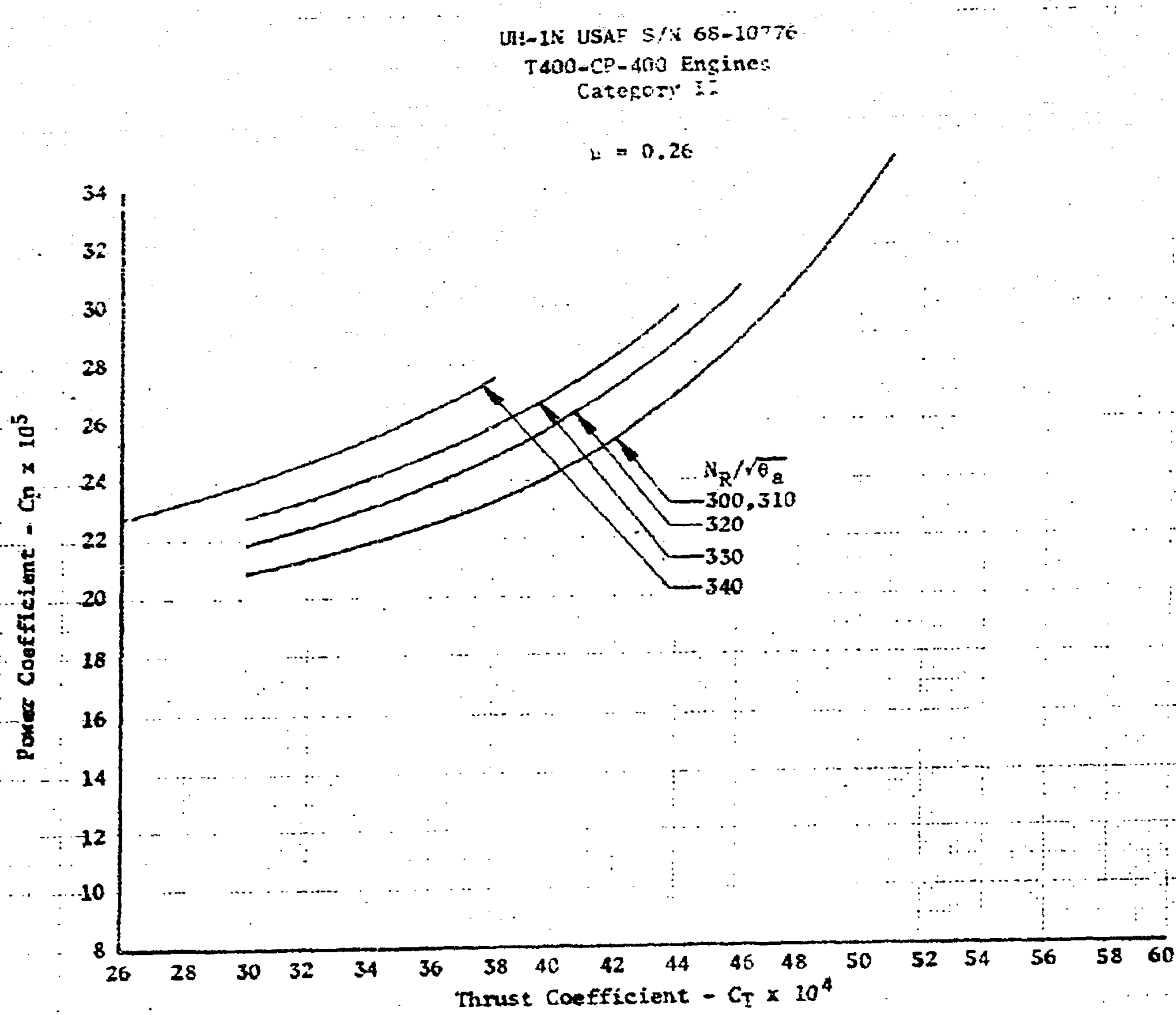


Figure 51 Nondimensional Level Flight Performance Summary

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 1
C_T = 0.0028
W/δ_a = 8,780
$N_R/\sqrt{\theta_a}$ = 339.5
Avg N_R (rpm) = 315.2
Loading = CLEAN

Avg Pressure Altitude (Ft) = 3,250
Avg Free Air Temp. (°C) = -24.8
Avg Gross Weight (Lb) = 7,800
Avg cg Location (Sta) = 136.9
NOTE - TAILED SYMBOLS INDICATE BLEED AIR ON FOR HEAT

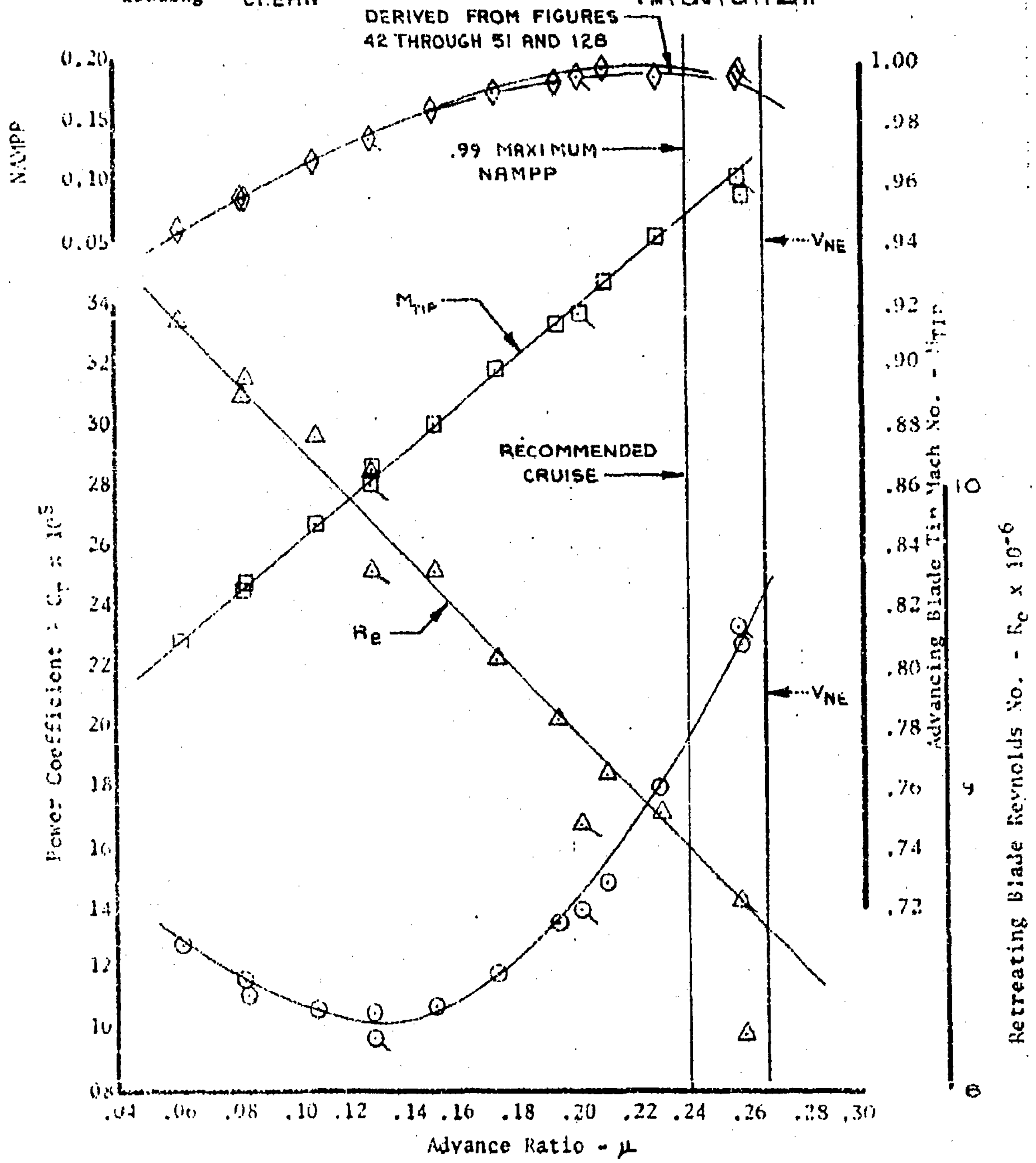


Figure 52. Nondimensional Level Flight Performance

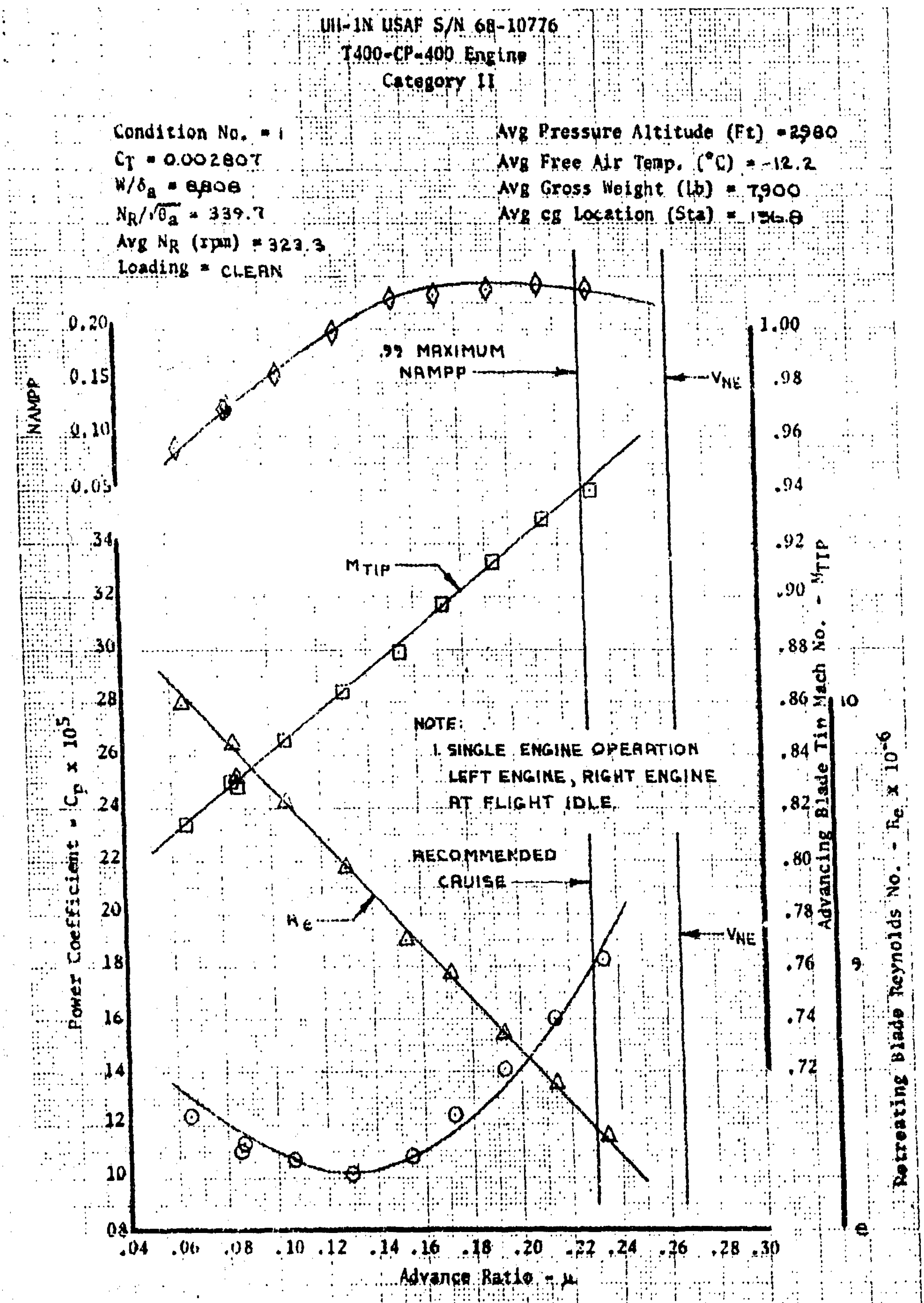


Figure 53. Nondimensional Level Flight Performance

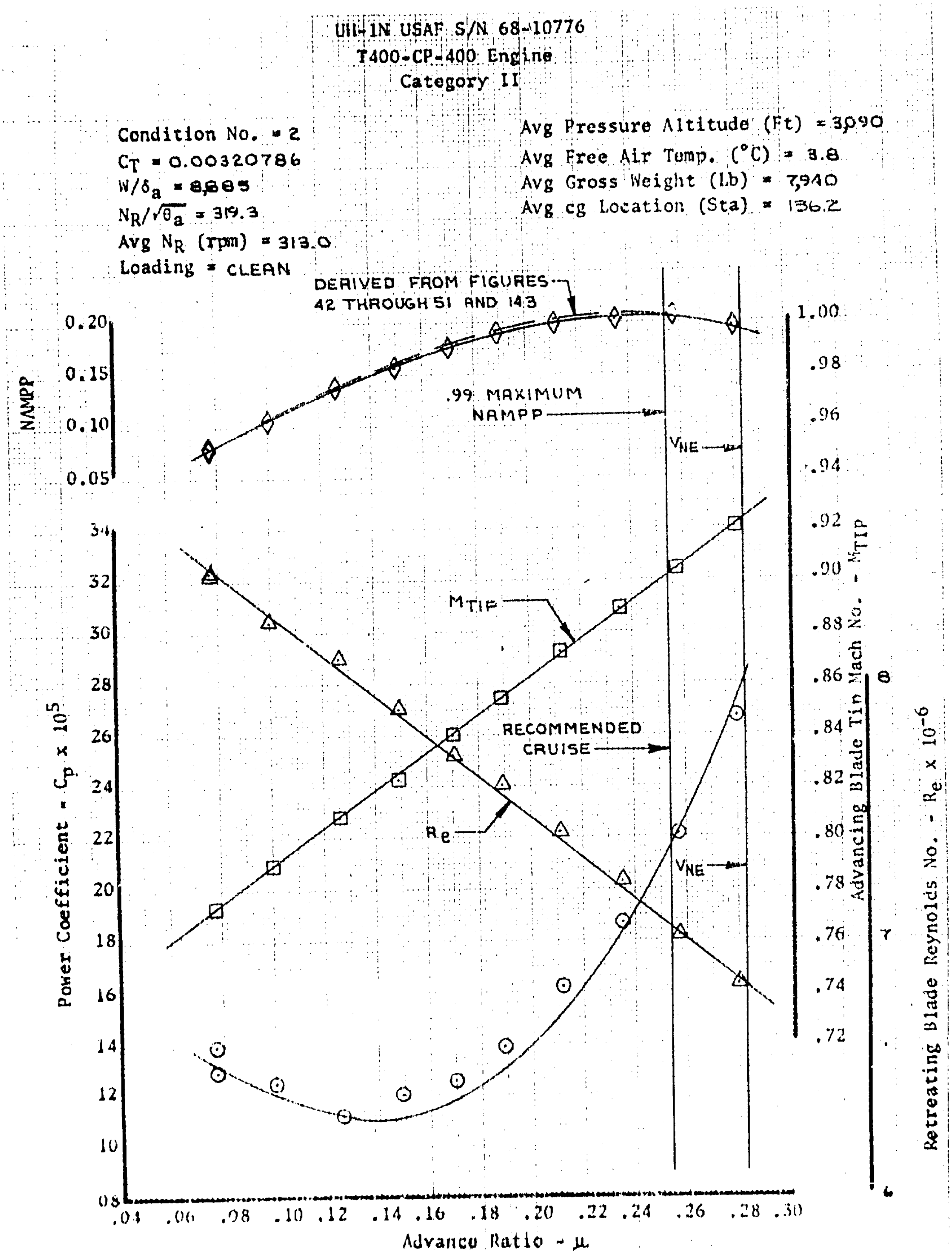


Figure 54 Nondimensional Level Flight Performance

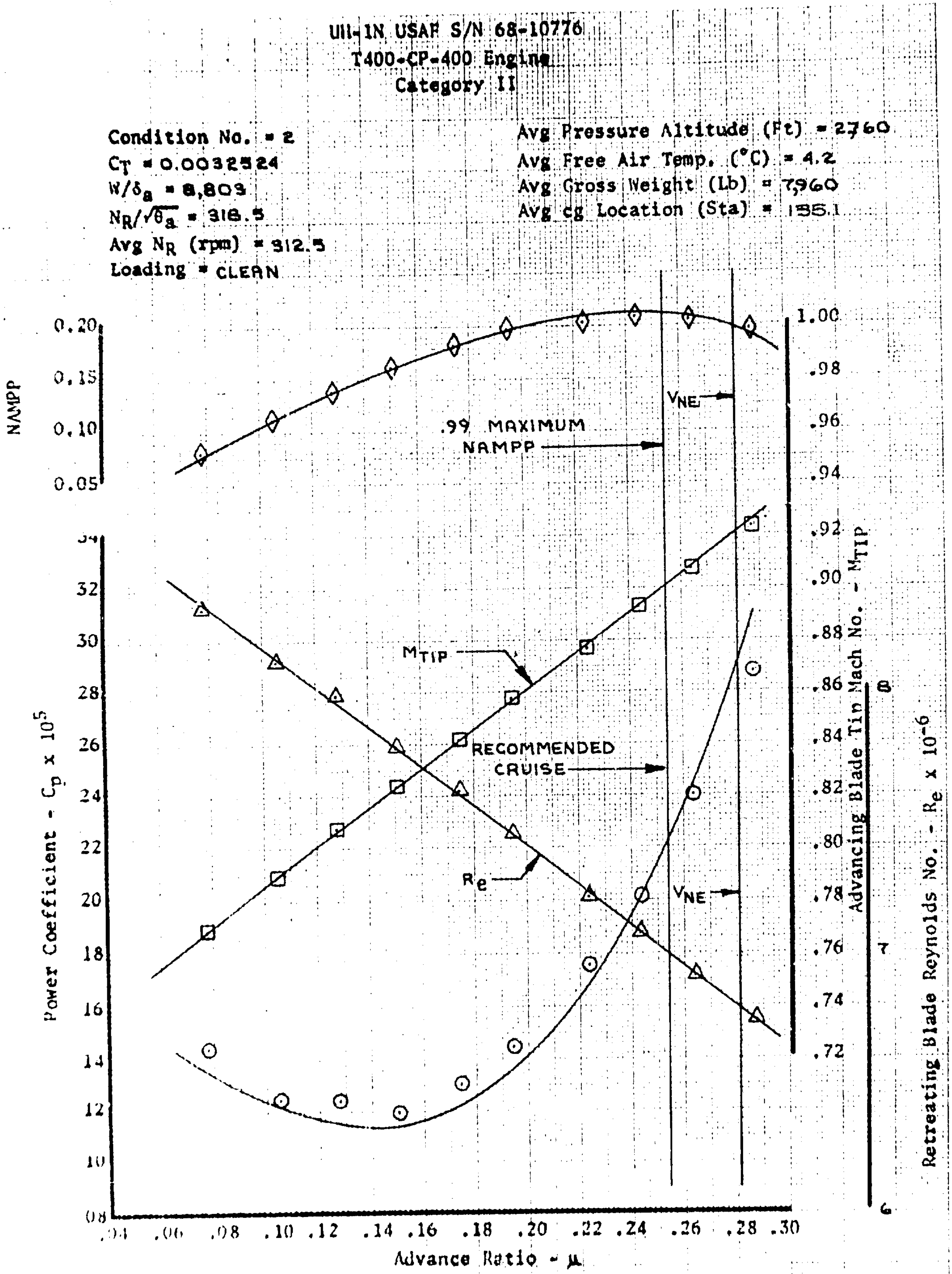


Figure 55. Nondimensional Level Flight Performance

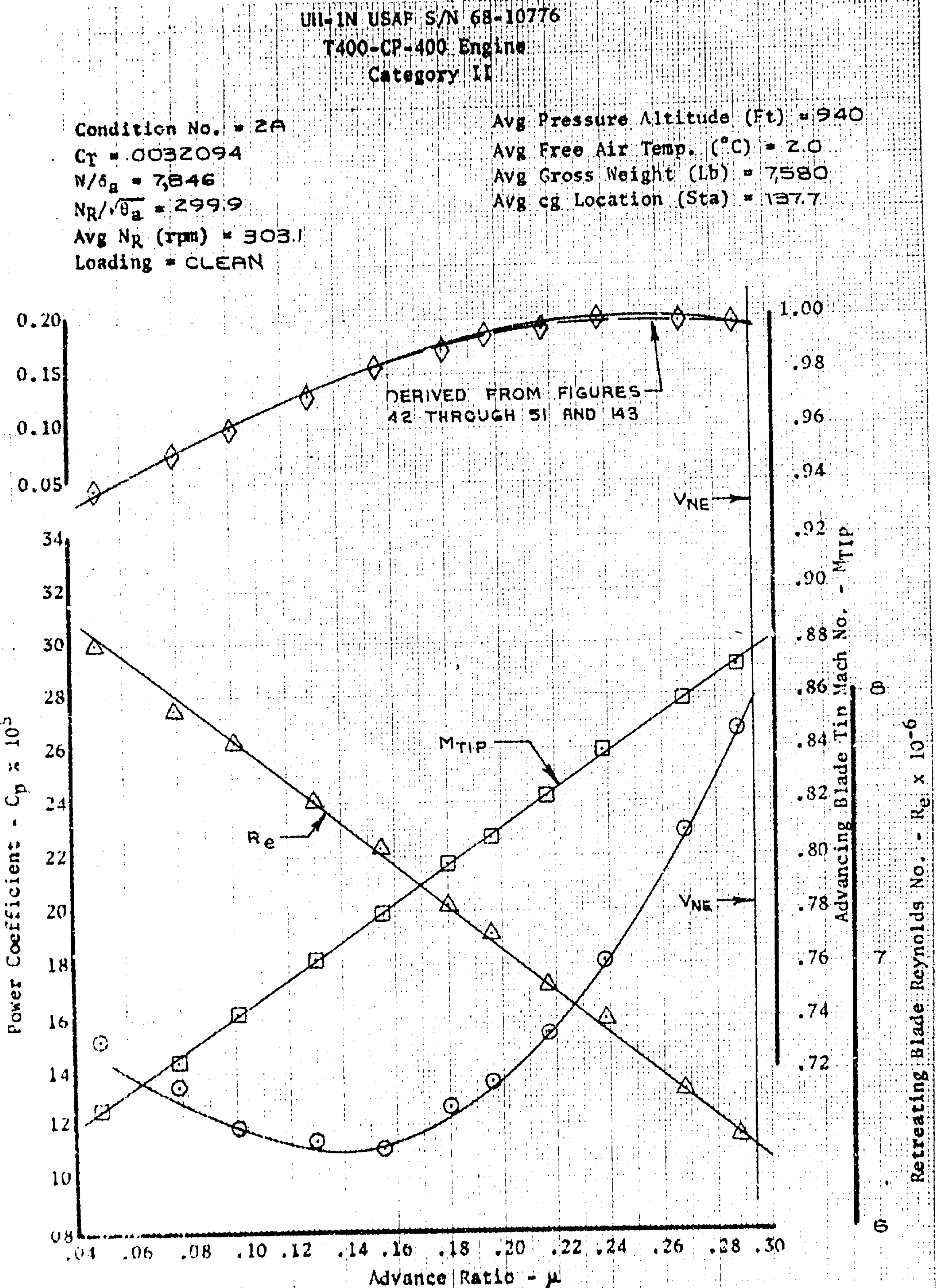


Figure 56. Nondimensional Level Flight Performance

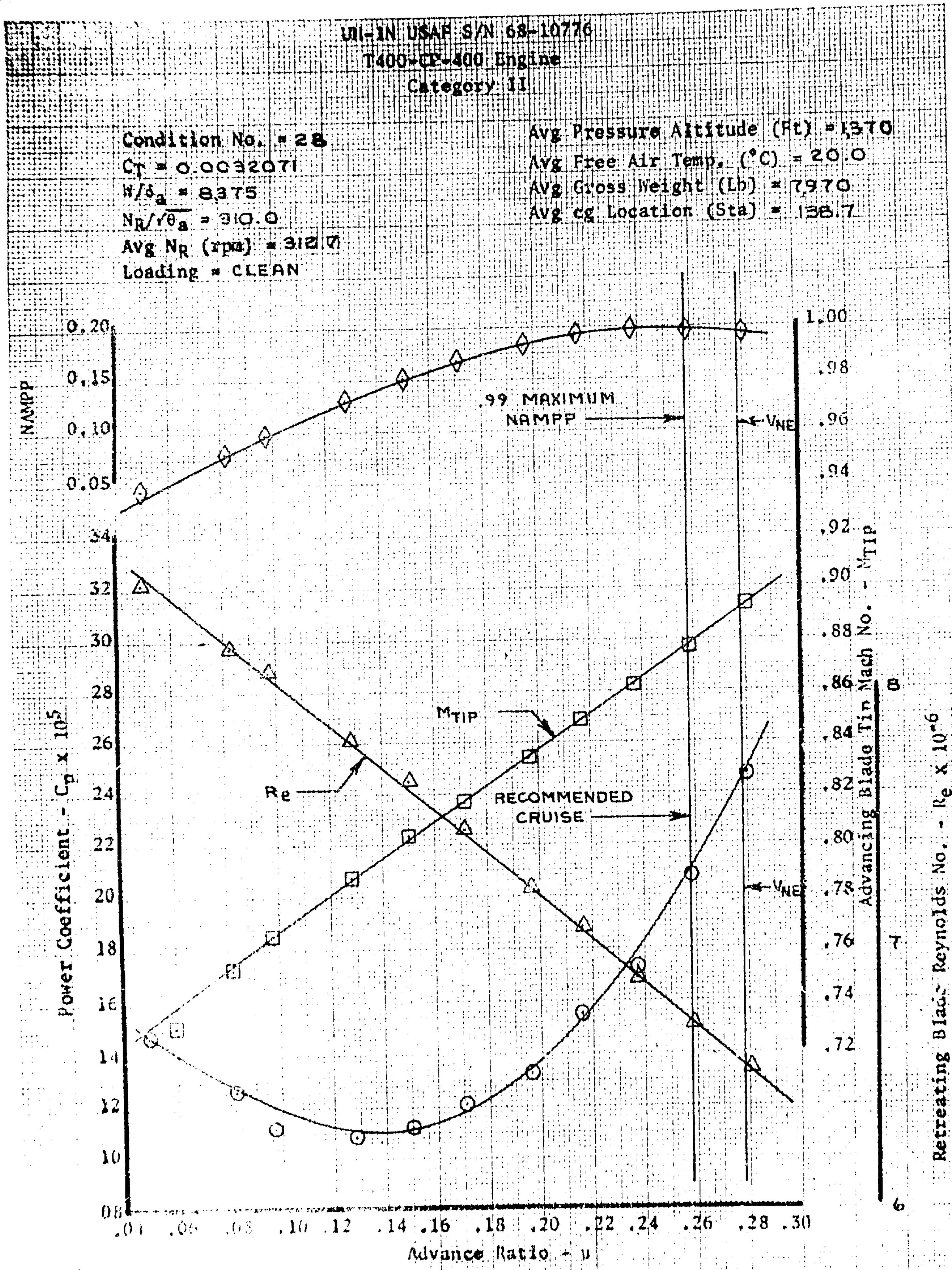


Figure 5?. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 8
C_T = 0.0032
W/δ_a = 9,553
$N_R/\sqrt{\theta_a}$ = 331.5
Avg N_R (rpm) = 318.5
Loading = CLEAN

Avg Pressure Altitude (Ft) = 3420
Avg Free Air Temp. (°C) = -7.1
Avg Gross Weight (lb) = 8430
Avg cg Location (Sta) = 138.0

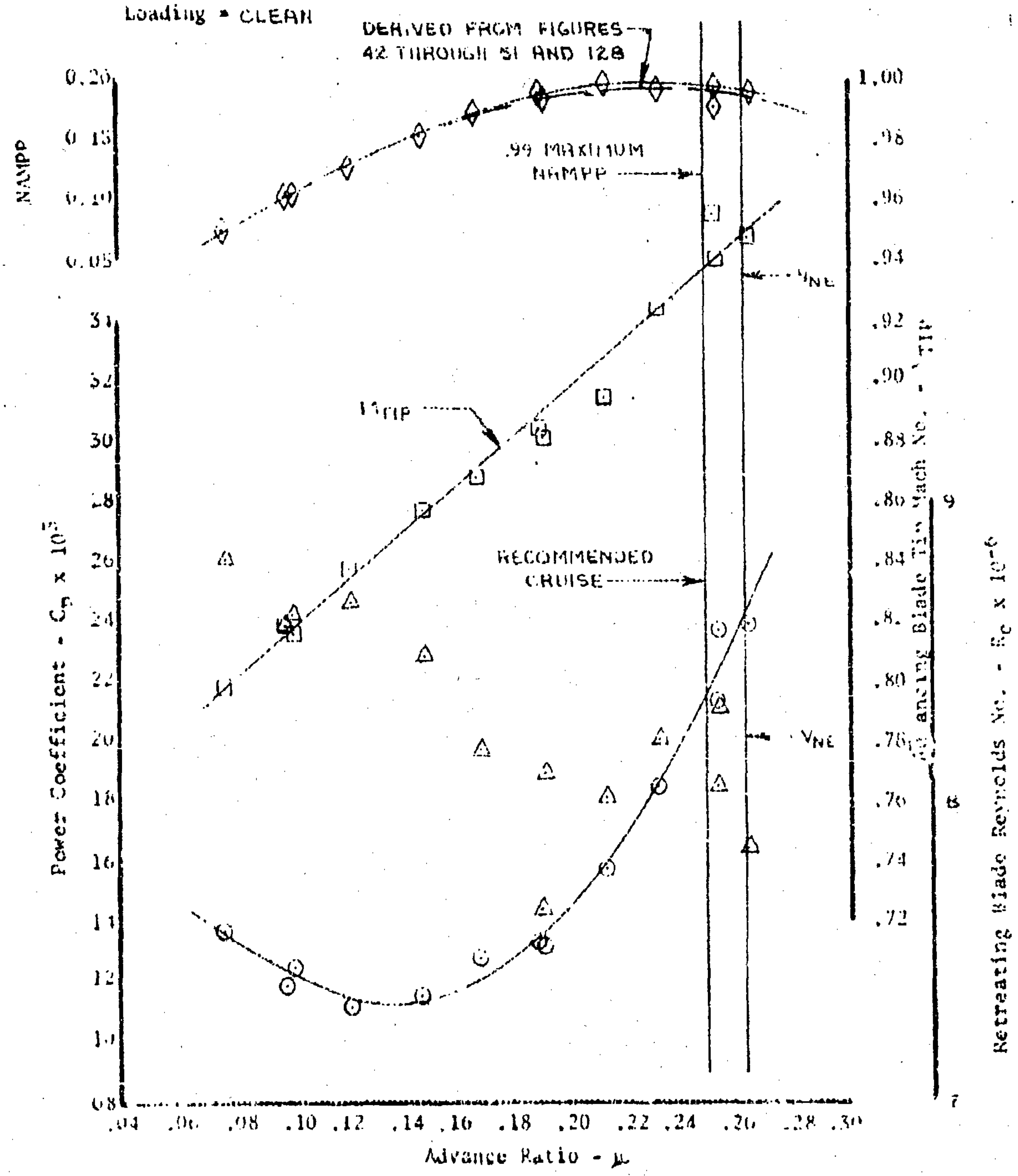


Figure 56. Nondimensional Level Flight Performance

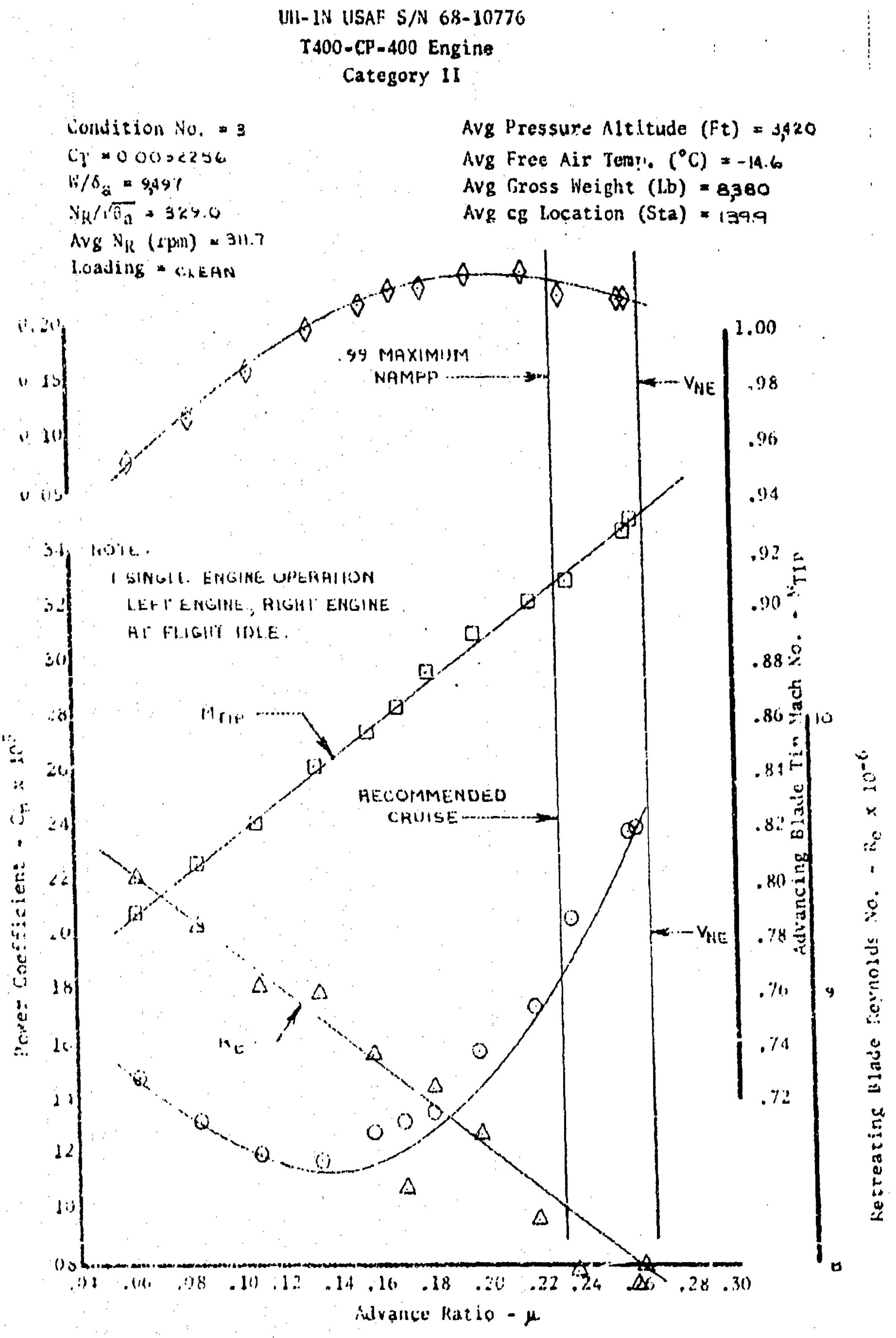


Figure 59 Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

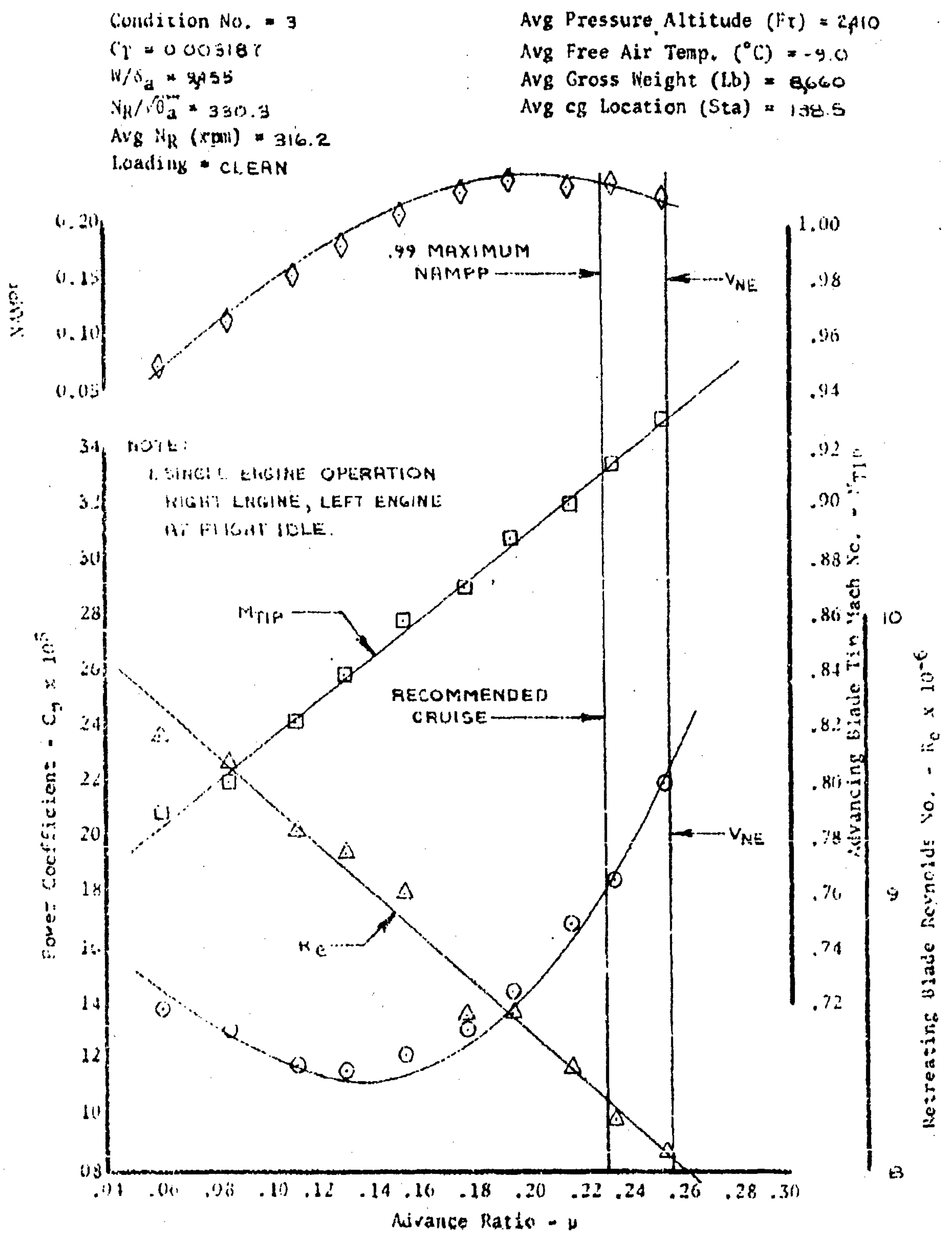


Figure 60. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 4
C_T = 0.003189
W/δ_a = 9,507
$N_R/\sqrt{\theta_a}$ = 552.6
Avg N_R (rpm) = 323.9
Loading = CLEAN

Avg Pressure Altitude (Ft) = 3260
Avg Free Air Temp. (°C) = 0.0
Avg Gross Weight (Lb) = 8,510
Avg cg Location (Sta) = 136.5
NOTE - TAILED SYMBOLS INDICATE BLEED AIR ON FOR HEAT

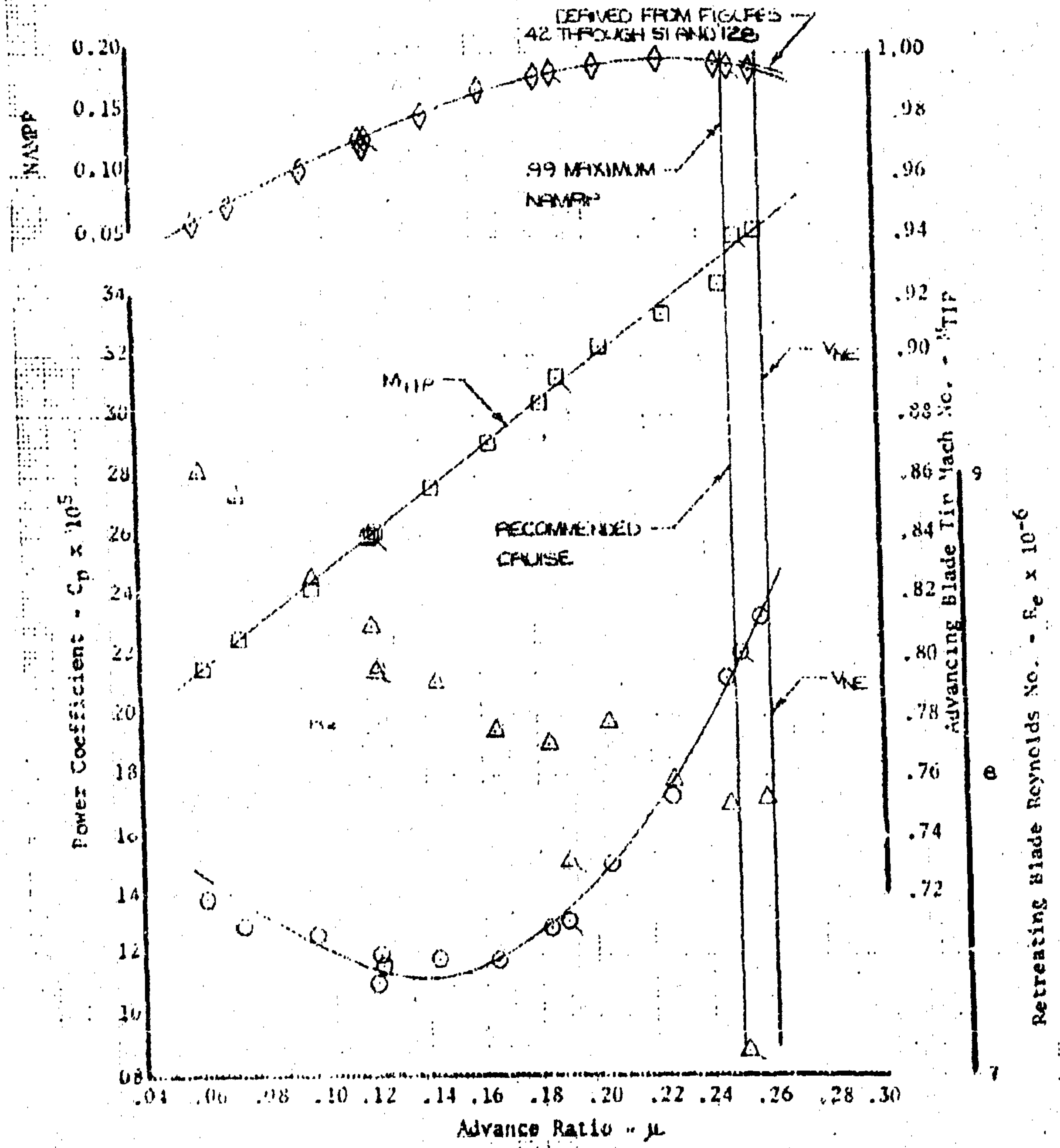


Figure 61. Nondimensional Level Flight Performance

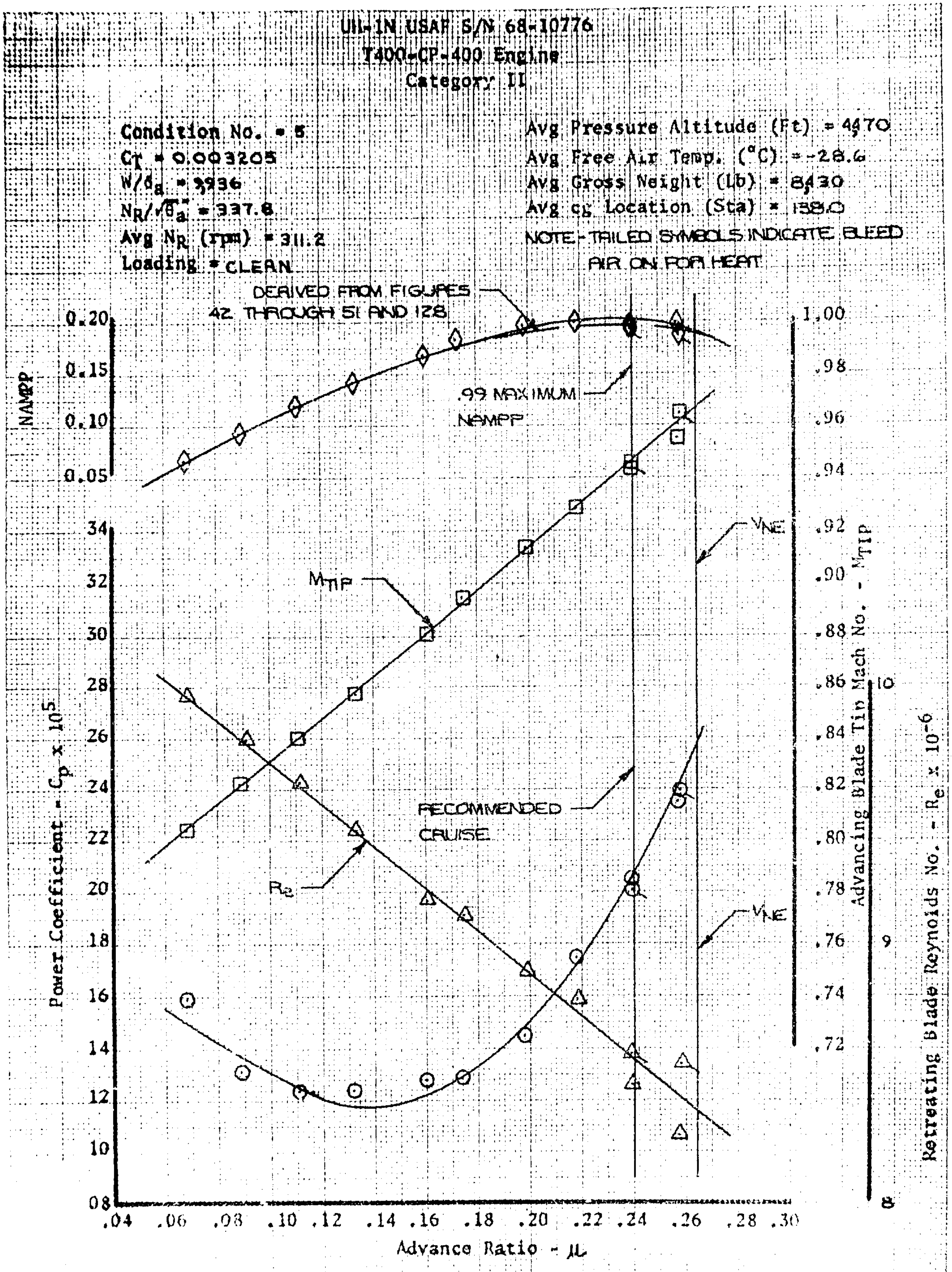


Figure 62. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 6
C_T = 0.003233
W/δ_a = 10,076
$N_R/\sqrt{\theta_a}$ = 338.6
Avg N_R (rpm) = 313.9
Loading = CLEAN

Avg Pressure Altitude (Ft) = 5,760
Avg Free Air Temp. (°C) = -25.5
Avg Gross Weight (Lb) = 8,150
Avg cg Location (Sta) = 139.7
NOTE - TAILED SYMBOLS INDICATE BLEED AIR ON FOR HEAT

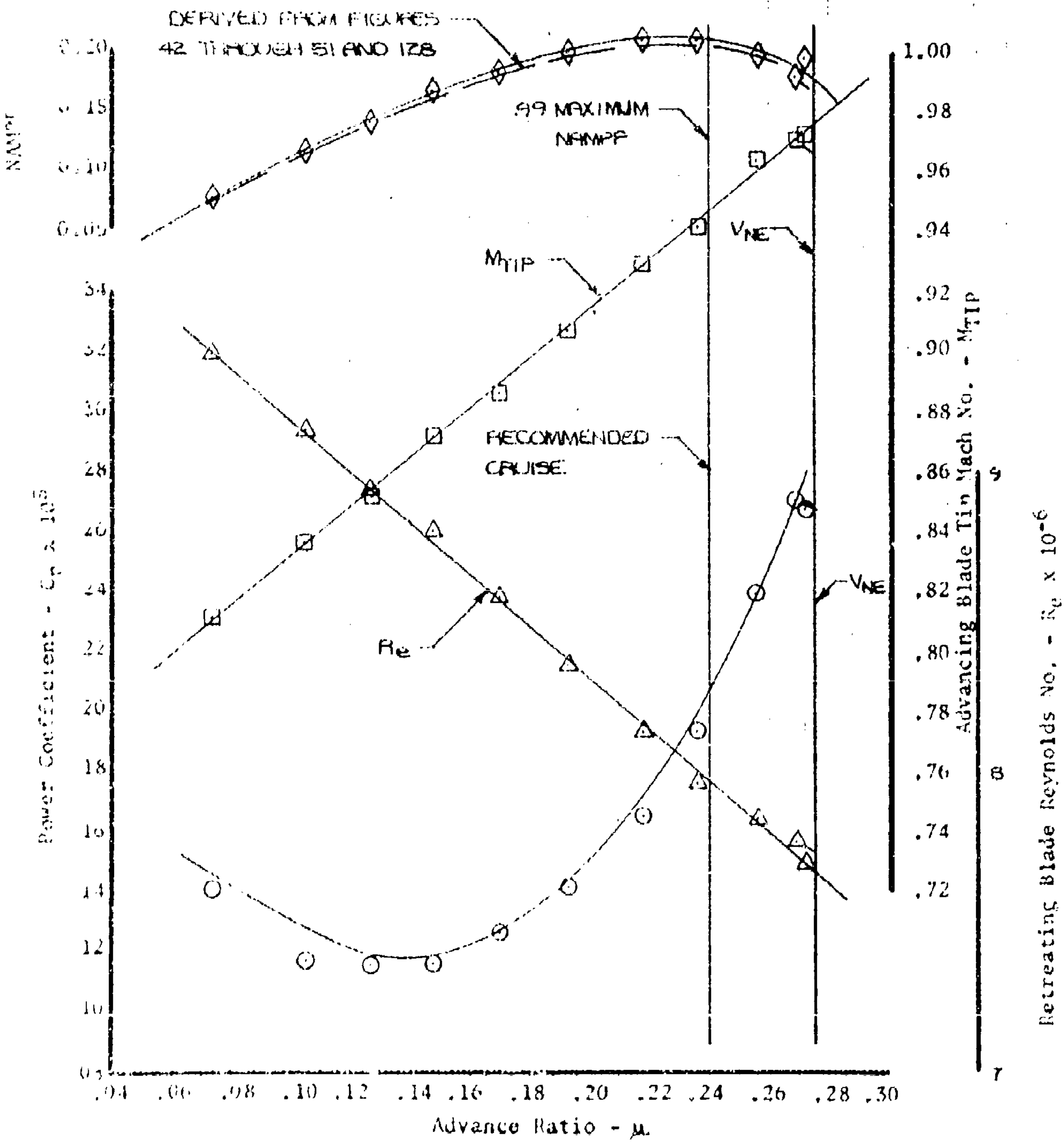


Figure 63 Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 7
C_T = 0.0031662
W/δ_a = 10,091
$N_R/\sqrt{\theta_a}$ = 341.4
Avg N_R (rpm) = 315.1
Loading = CLEAN

Avg Pressure Altitude (Ft) = 4500
Avg Free Air Temp. (°C) = -27.6
Avg Gross Weight (Lb) = 8560
Avg cg Location (Sta) = 138.4

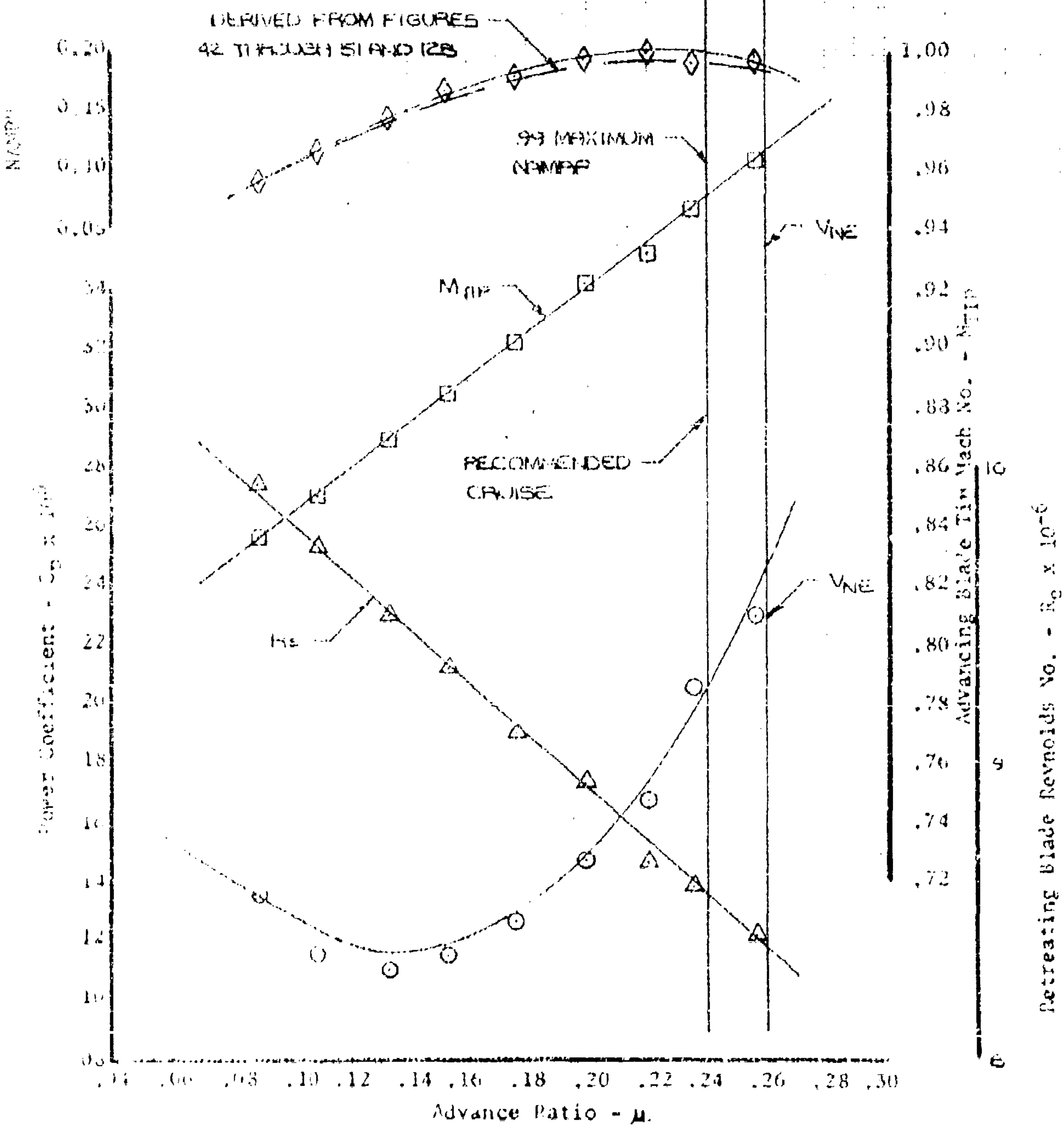


Figure C4. Nondimensional Level Flight Performance

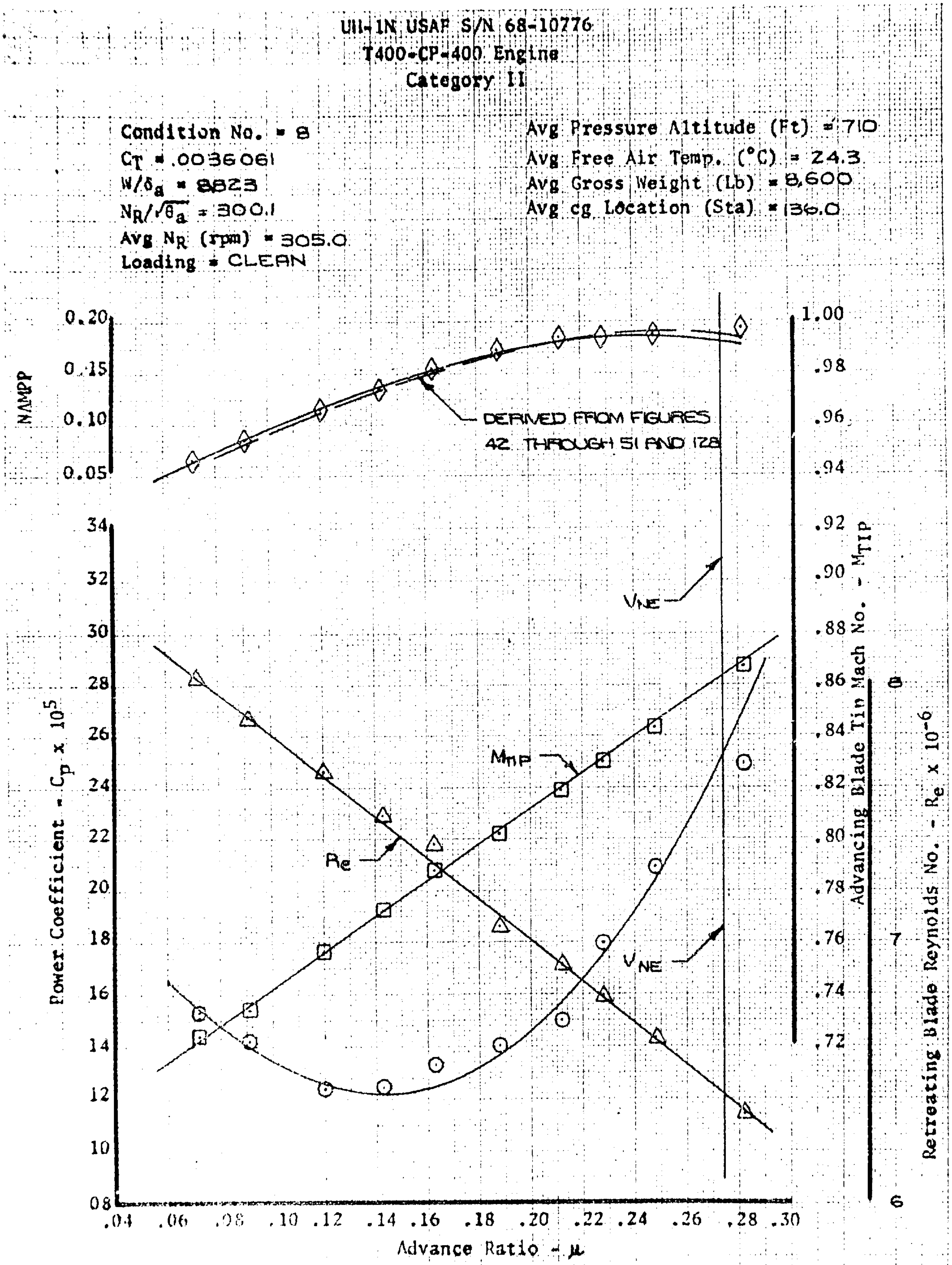


Figure 63. Nondimensional Level Flight Performance

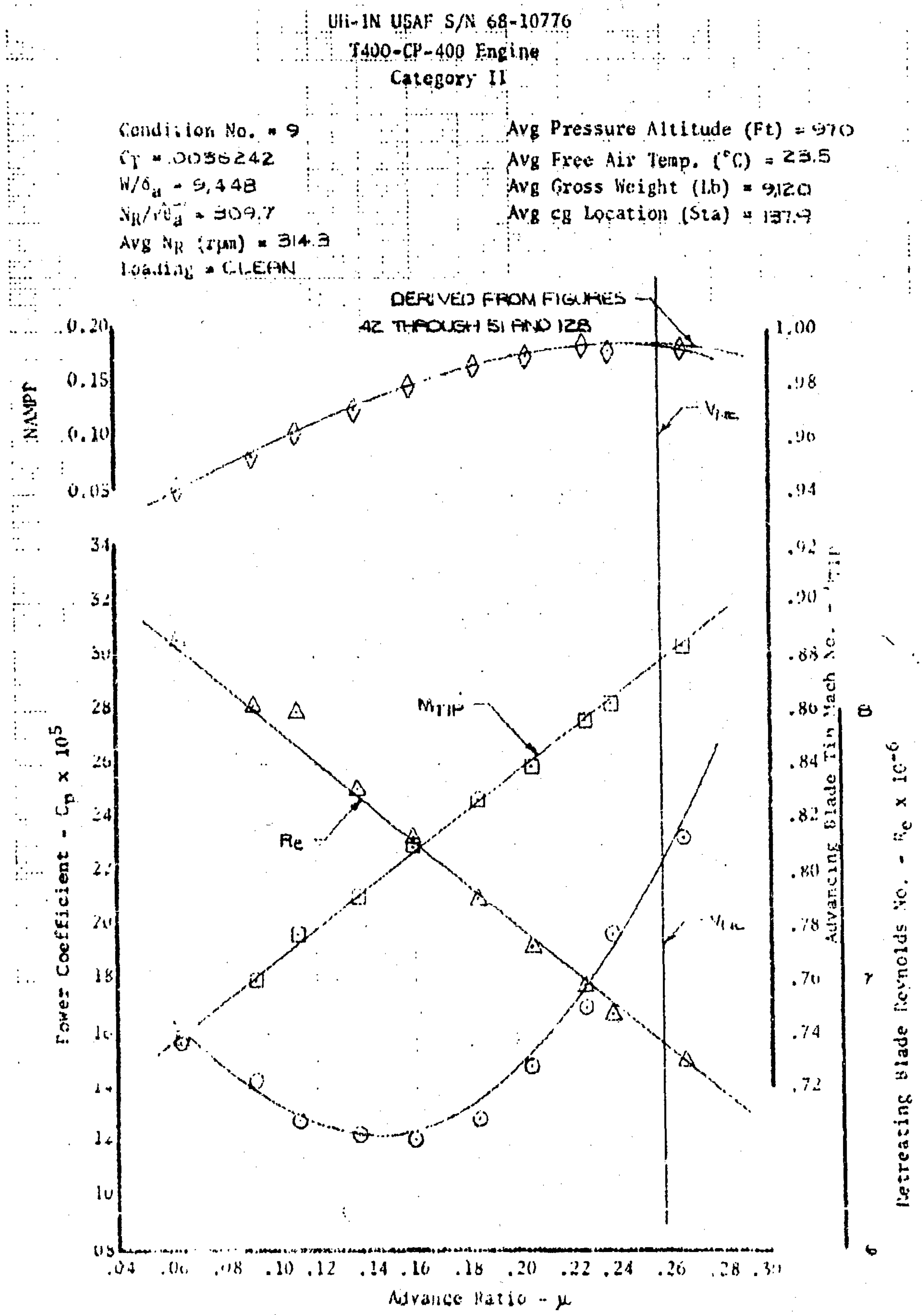


Figure 66 Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

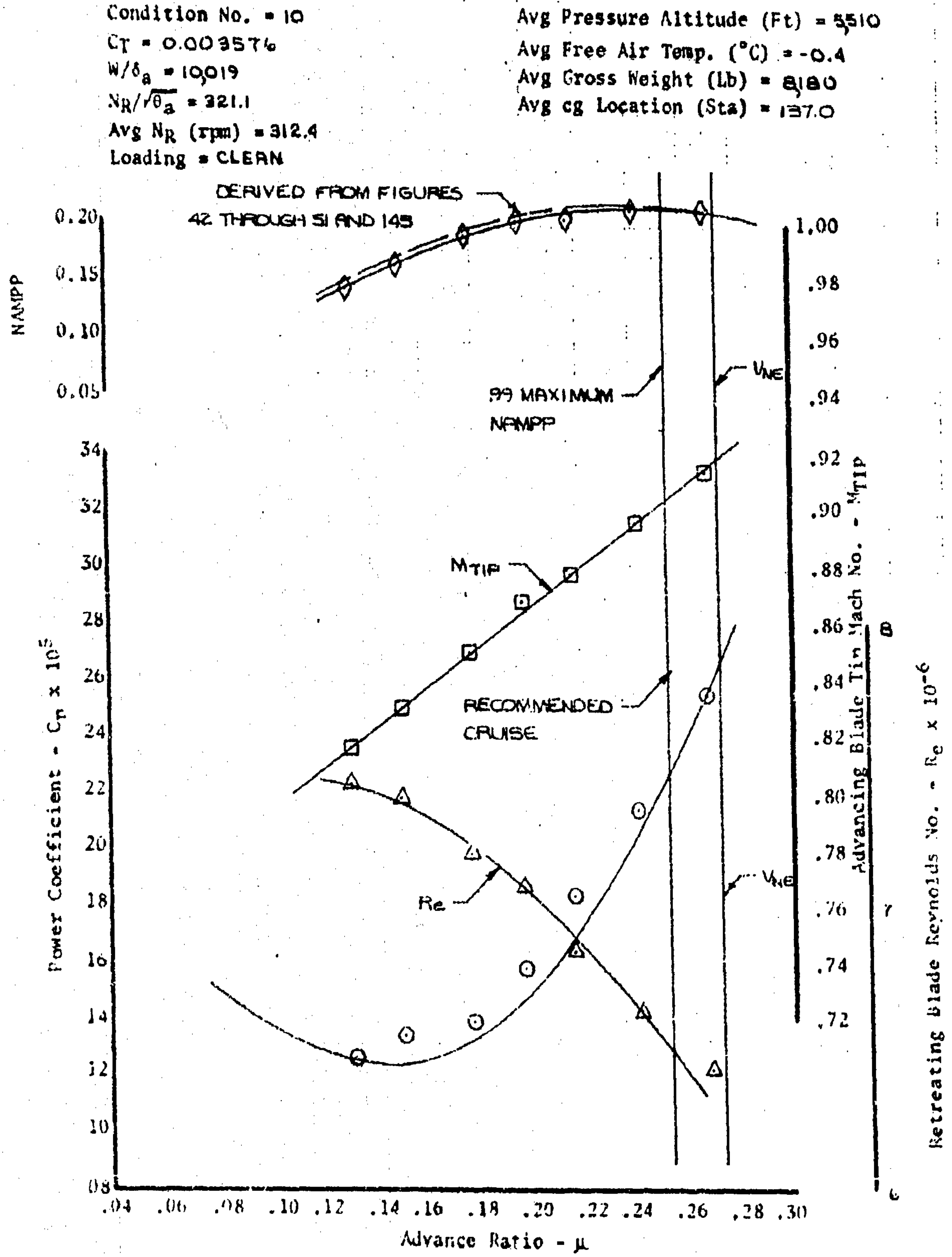


Figure 67 Nondimensional Level Flight Performance

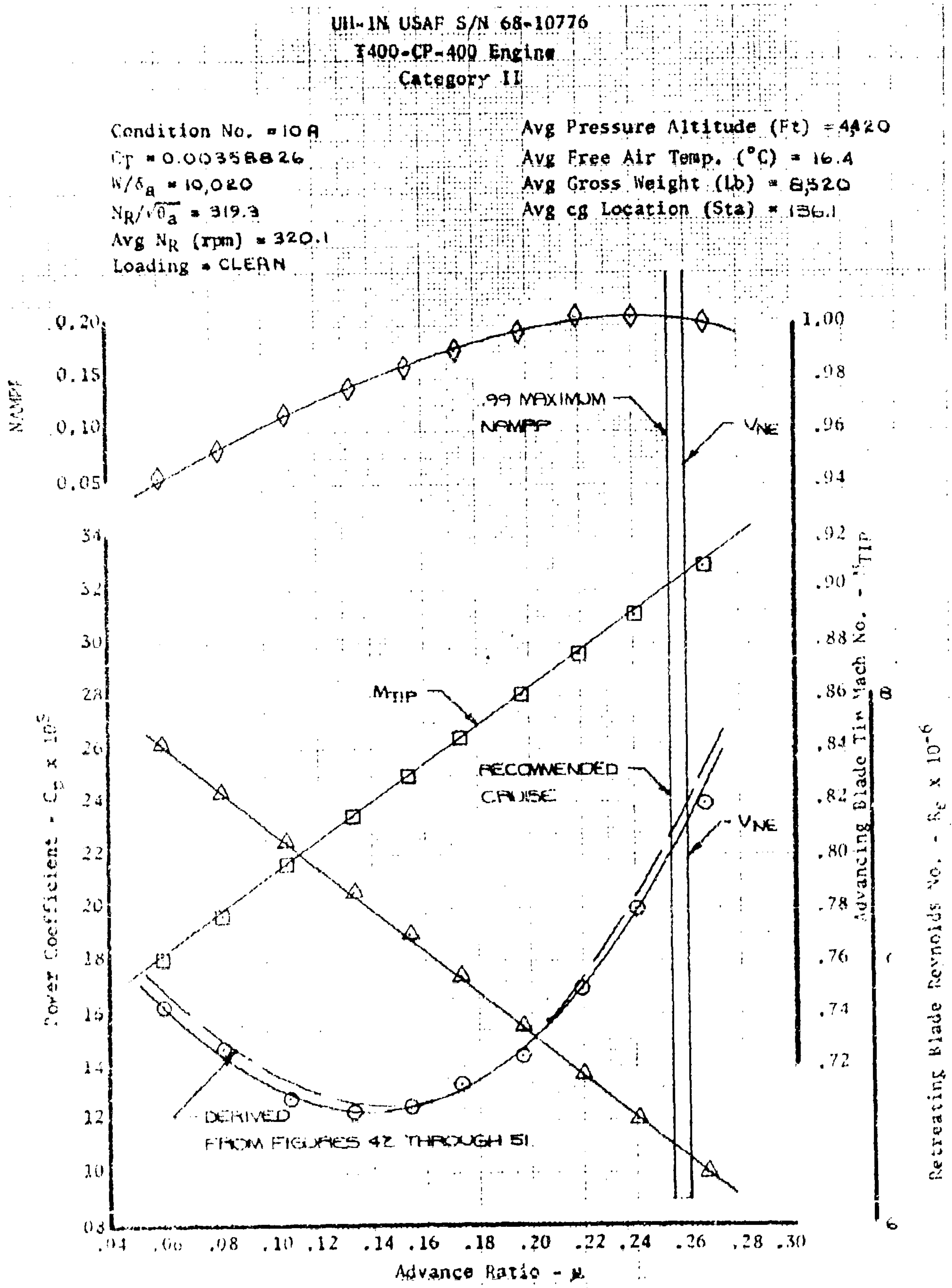


Figure 68. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 10
C_T = 0.00360501
W/δ_a = 10037
$N_R/\sqrt{\theta_a}$ = 320.1
Avg N_R (rpm) = 312.8
Loading = CLEAN

Avg Pressure Altitude (Ft) = 4650
Avg Free Air Temp. (°C) = 2.1
Avg Gross Weight (Lb) = 8460
Avg cg Location (Sta) = 138.0
NOTE - BLEED AIR FOR HEAT ON

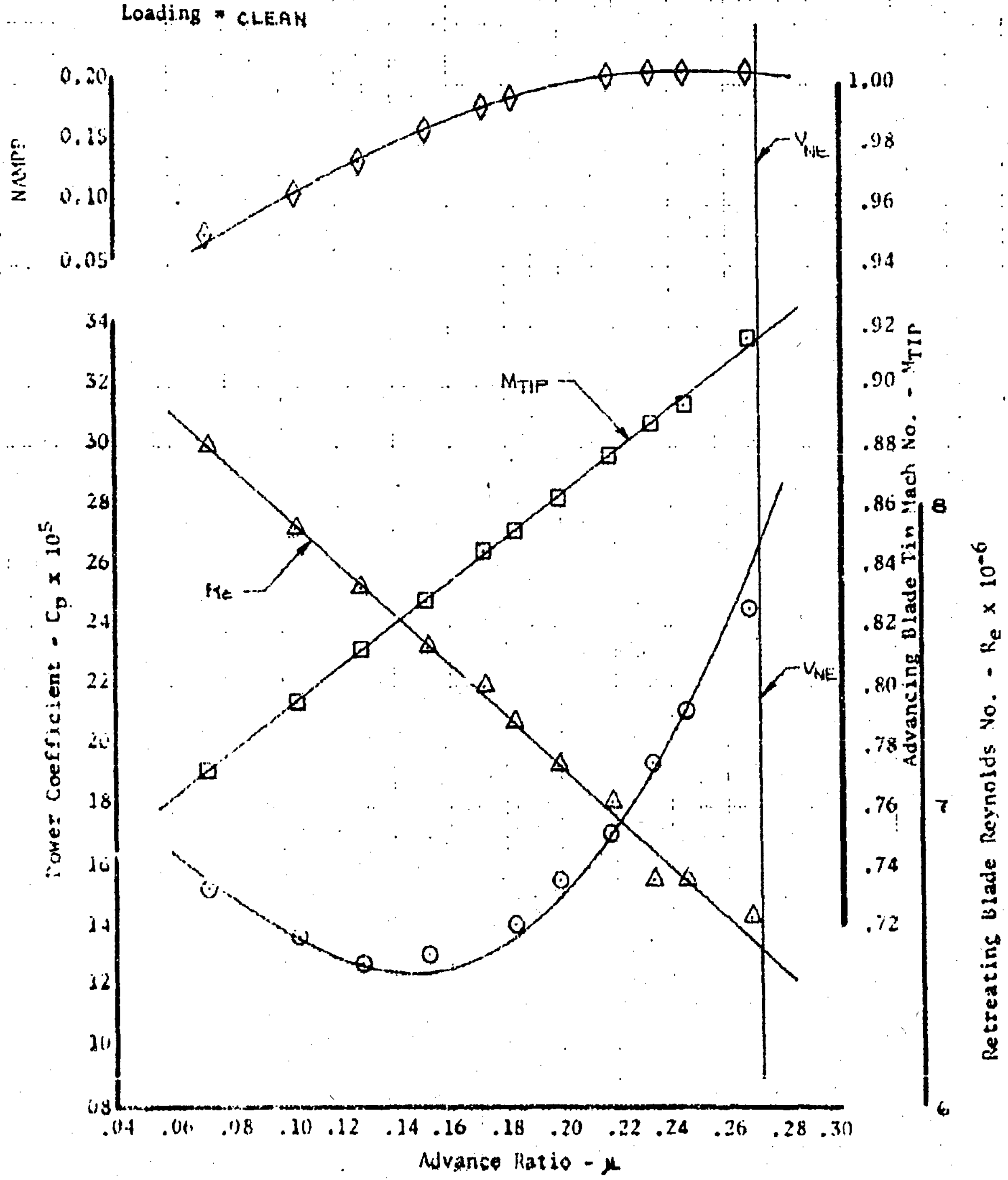


Figure 69 Nondimensional Level Flight Performance

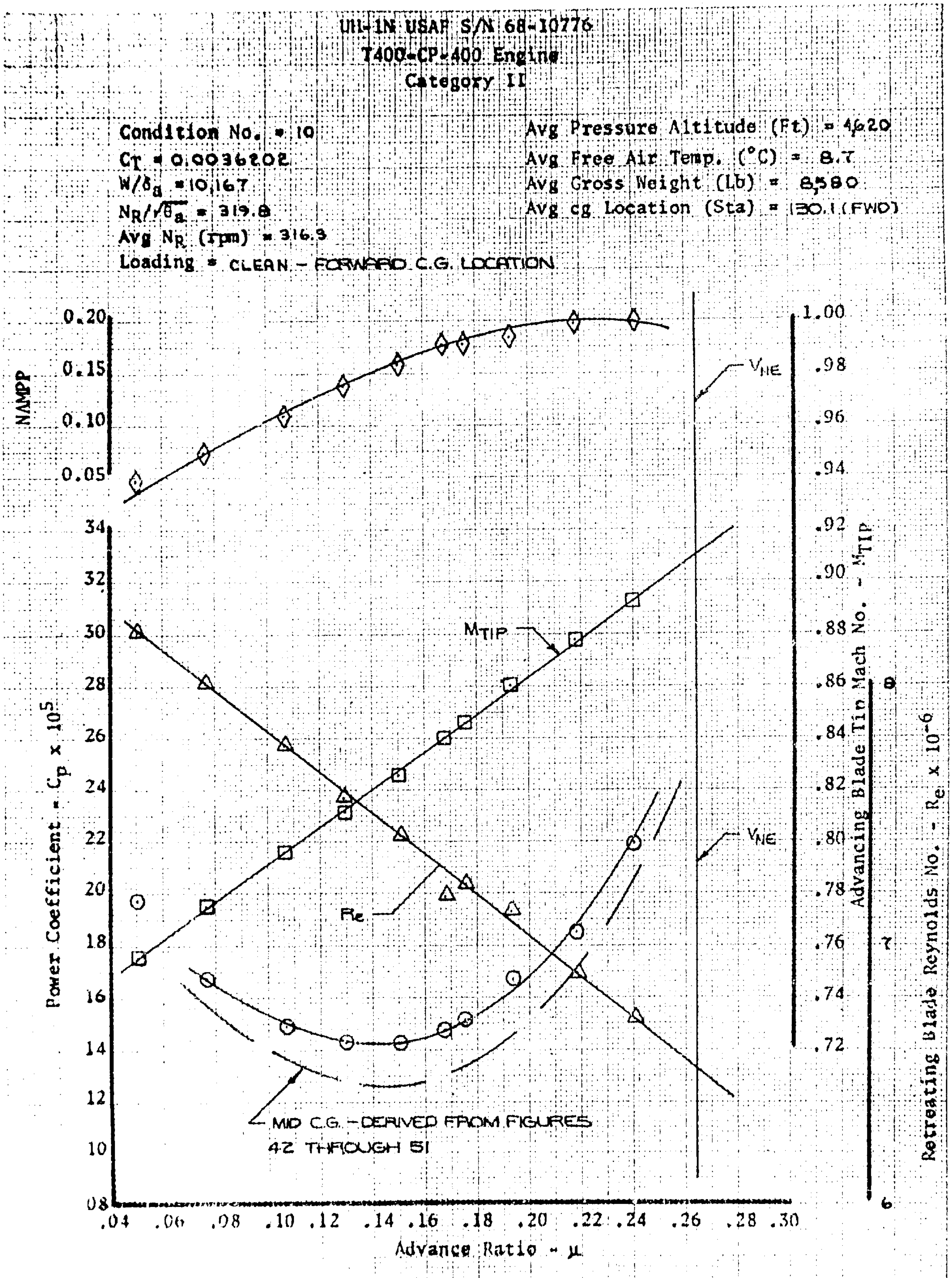


Figure 70 Nondimensional Level Flight Performance

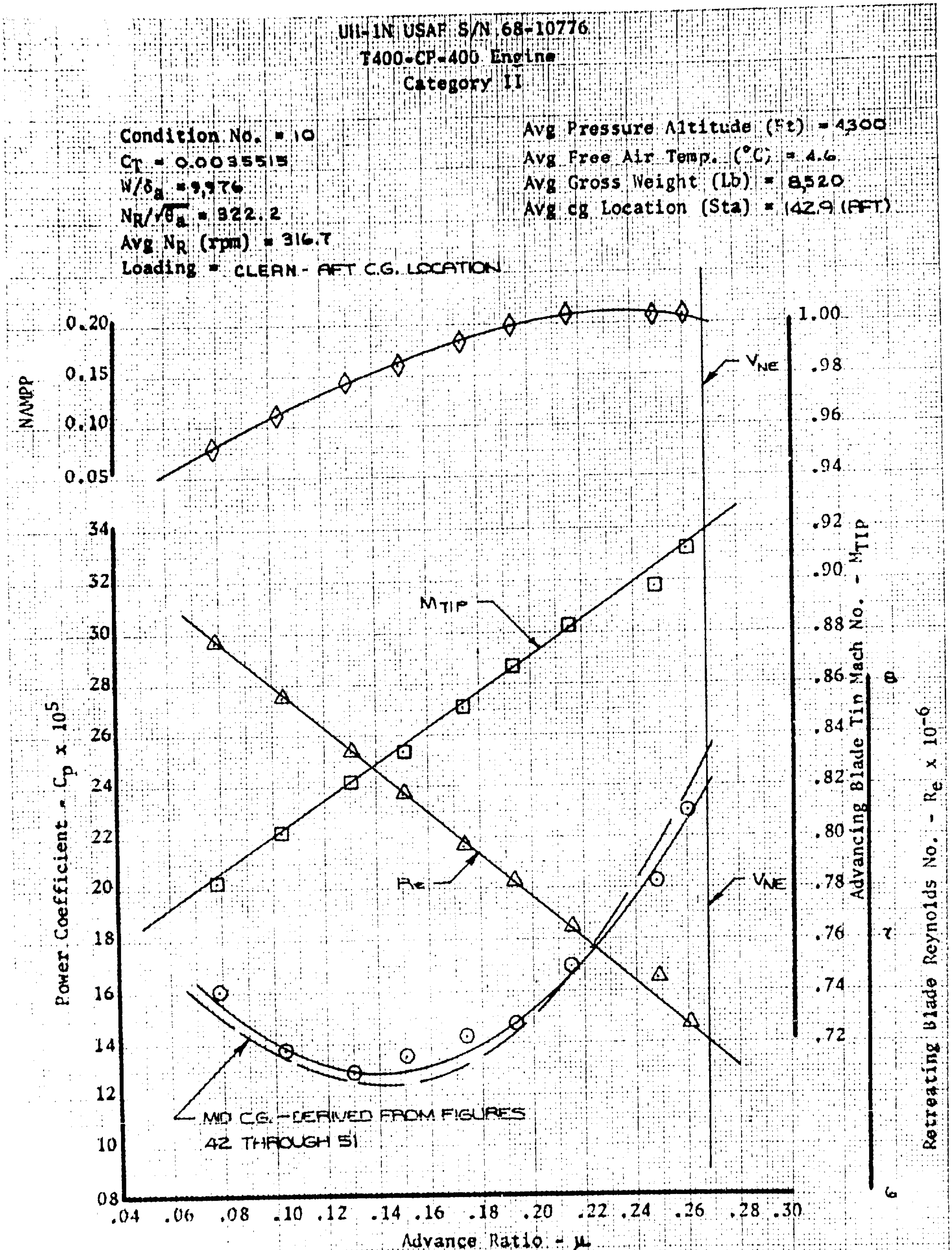


Figure 71. Nondimensional Level Flight Performance

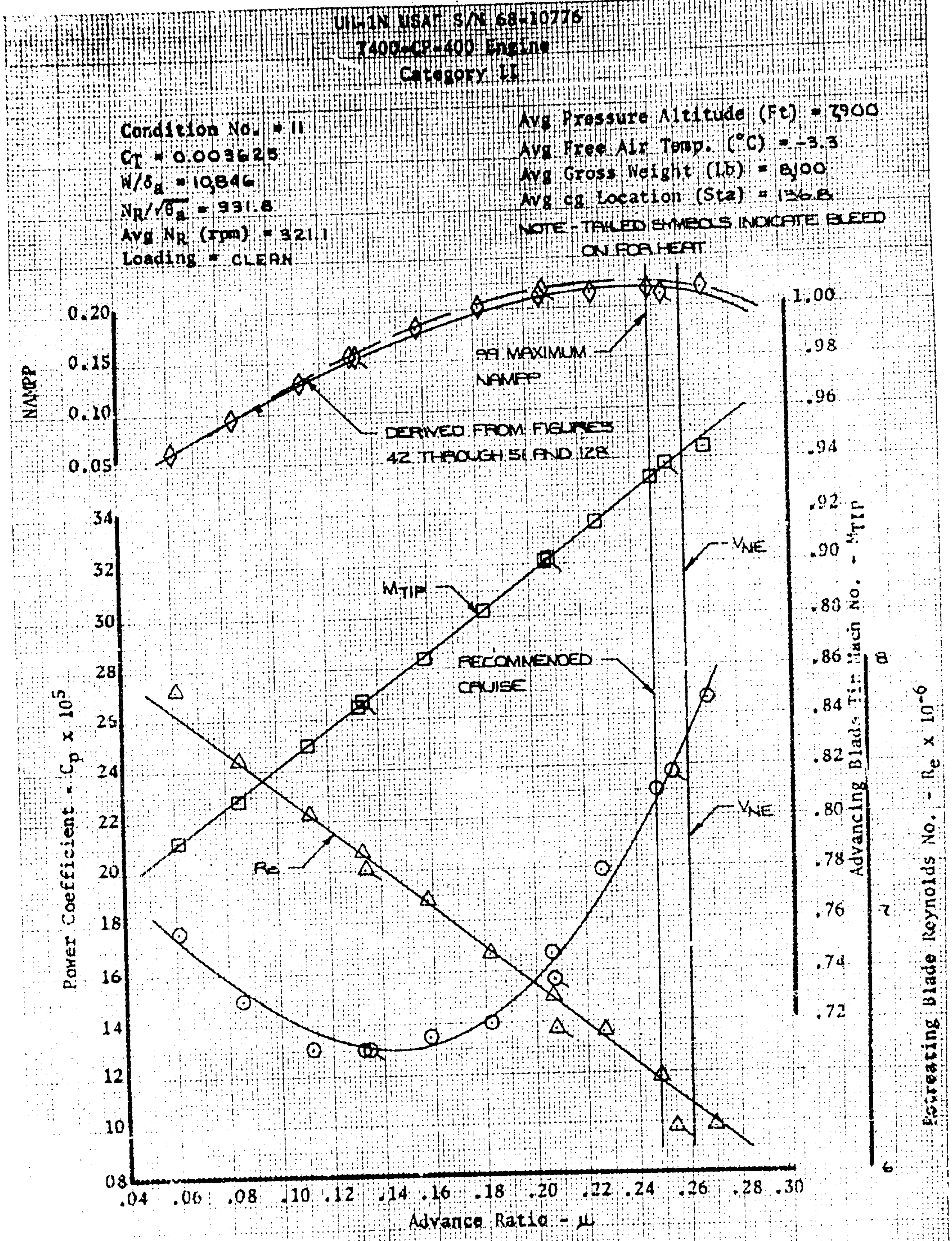


Figure 72. Nondimensional Level Flight Performance

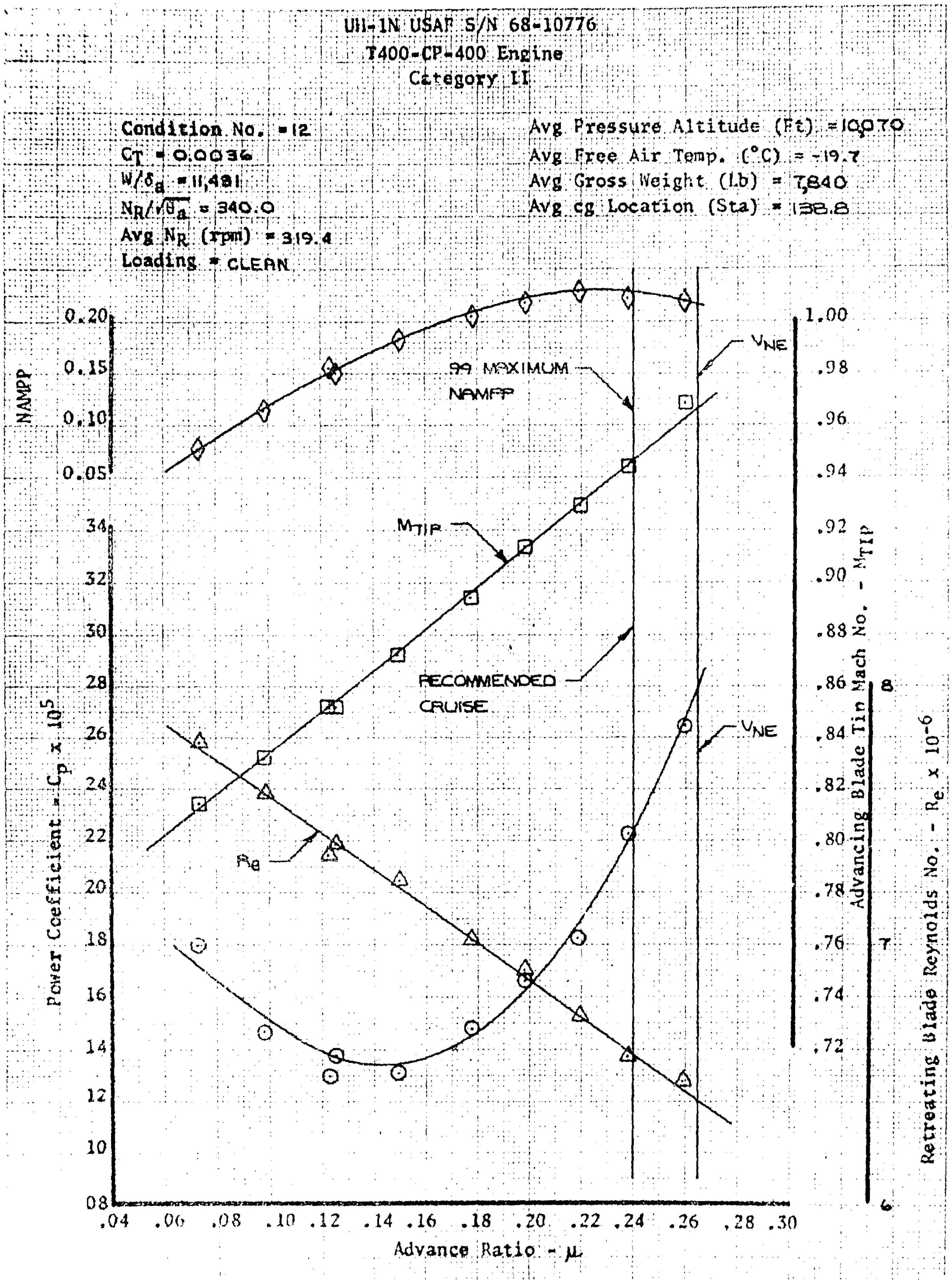


Figure 73. Nondimensional Level Flight Performance

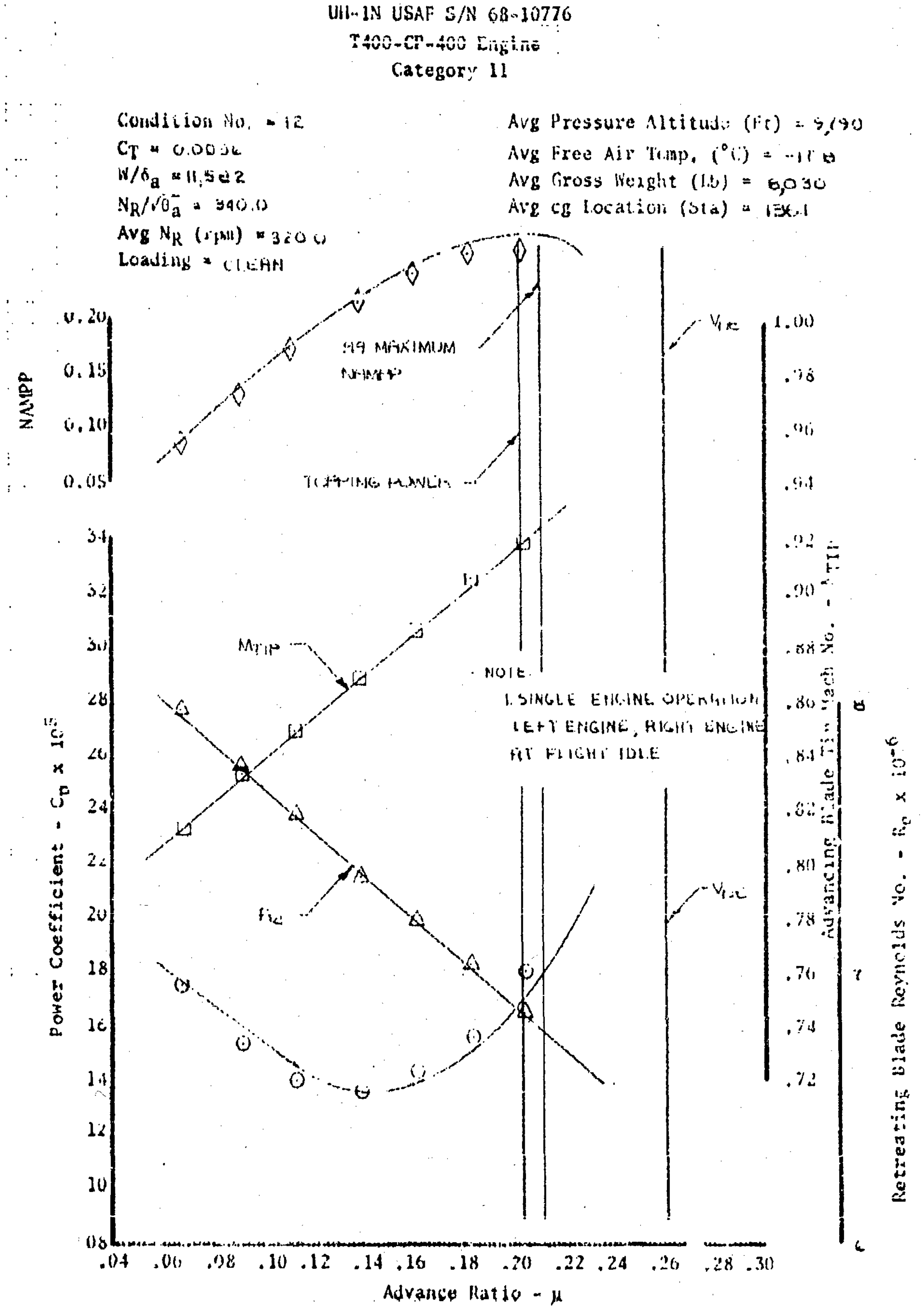


Figure 74. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 13
C_T = .0039917
W/δ_a = 9,800
$N_R/\sqrt{\theta_a}$ = 300.6
Avg N_R (rpm) = 304.6
Loading = CLEAN

Avg Pressure Altitude (Ft) = 1660
Avg Free Air Temp. (°C) = 22.8
Avg Gross Weight (Lb) = 9,230
Avg cg Location (Sta) = 136.2

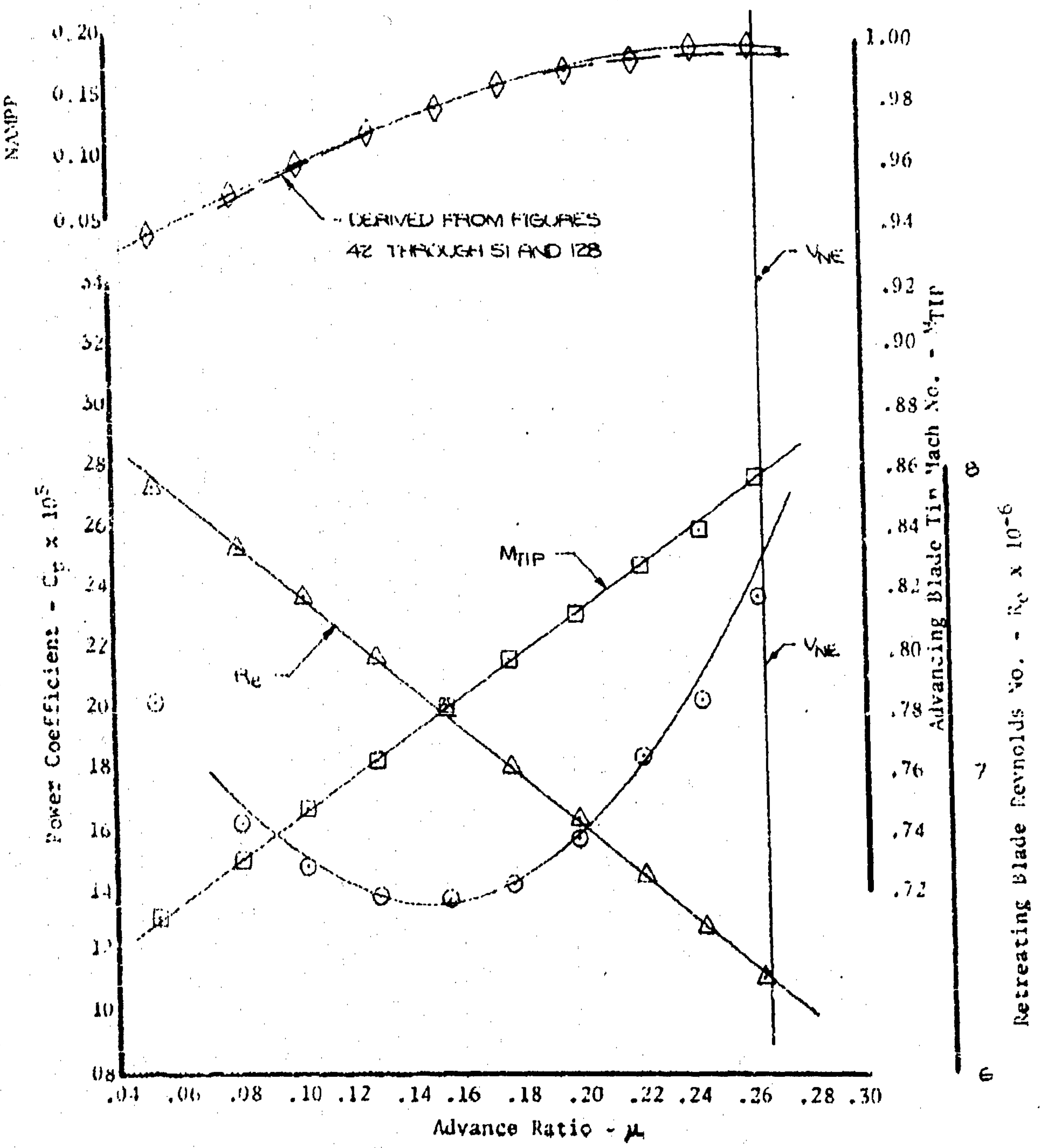


Figure 75. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 14
C_T = .0040071
W/δ_a = 10,450
$N_R/\sqrt{\theta_a}$ = 309.7
Avg N_R (rpm) = 309.7
Loading = CLEAN

Avg Pressure Altitude (Ft) = 4,860
Avg Free Air Temp. (°C) = 15.0
Avg Gross Weight (Lb) = 8,750
Avg cg Location (Sta) = 136.4

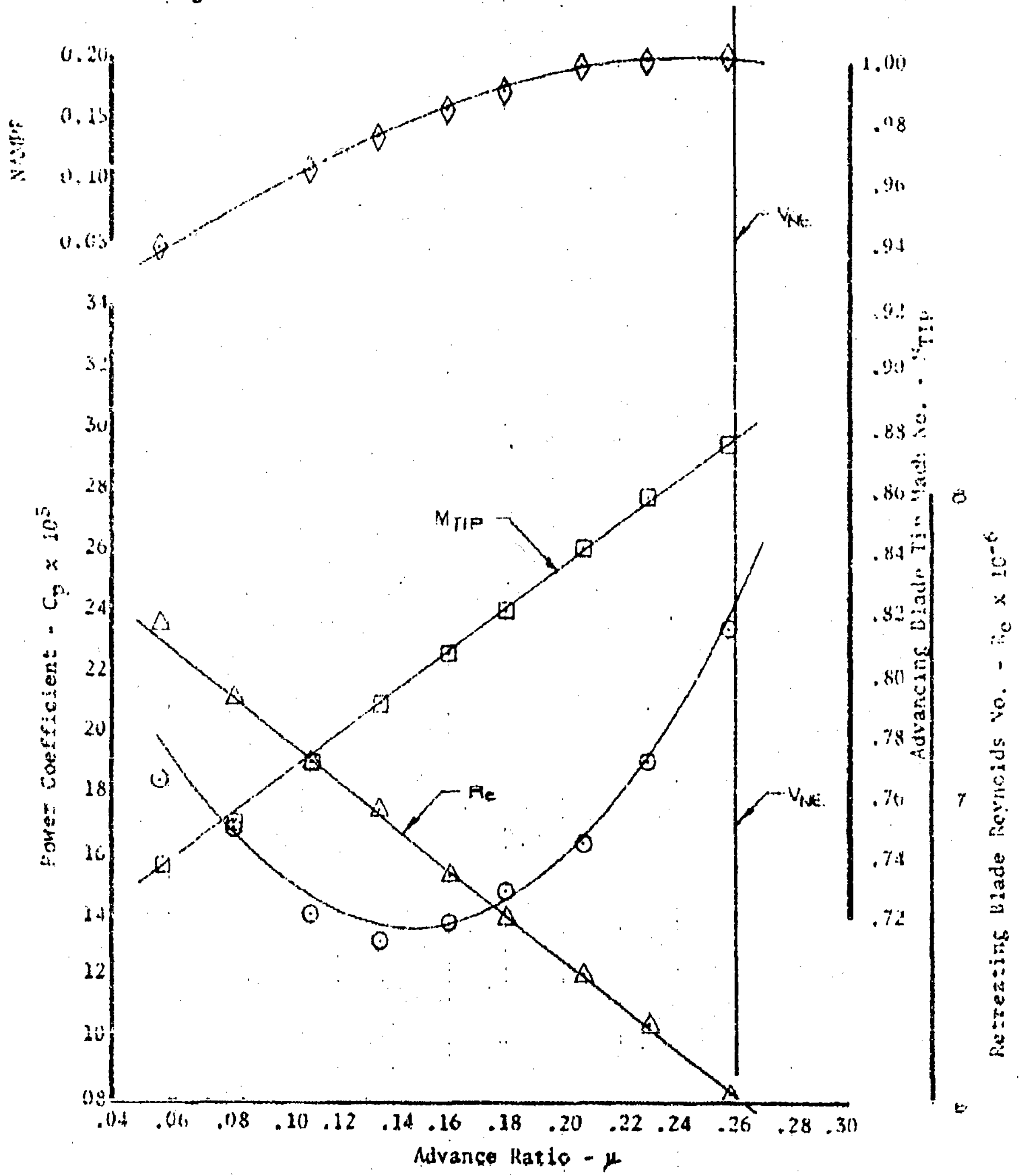


Figure 76. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 14
C_T = 0.0039945
W/δ_a = 10,436
$N_R/\sqrt{\theta_a}$ = 310.1
Avg N_R (rpm) = 315.8
Loading = CARGO DOORS OPEN, TWO XM-93 MINIGUNS EXTENDED FIXED TO FIRE FORWARD, AND TWO LAU-59/A ROCKET LAUNCHERS.

Avg Pressure Altitude (Ft) = 3300
Avg Free Air Temp. (°C) = 25.8
Avg Gross Weight (lb) = 9250
Avg cg Location (Sta) = 136.7

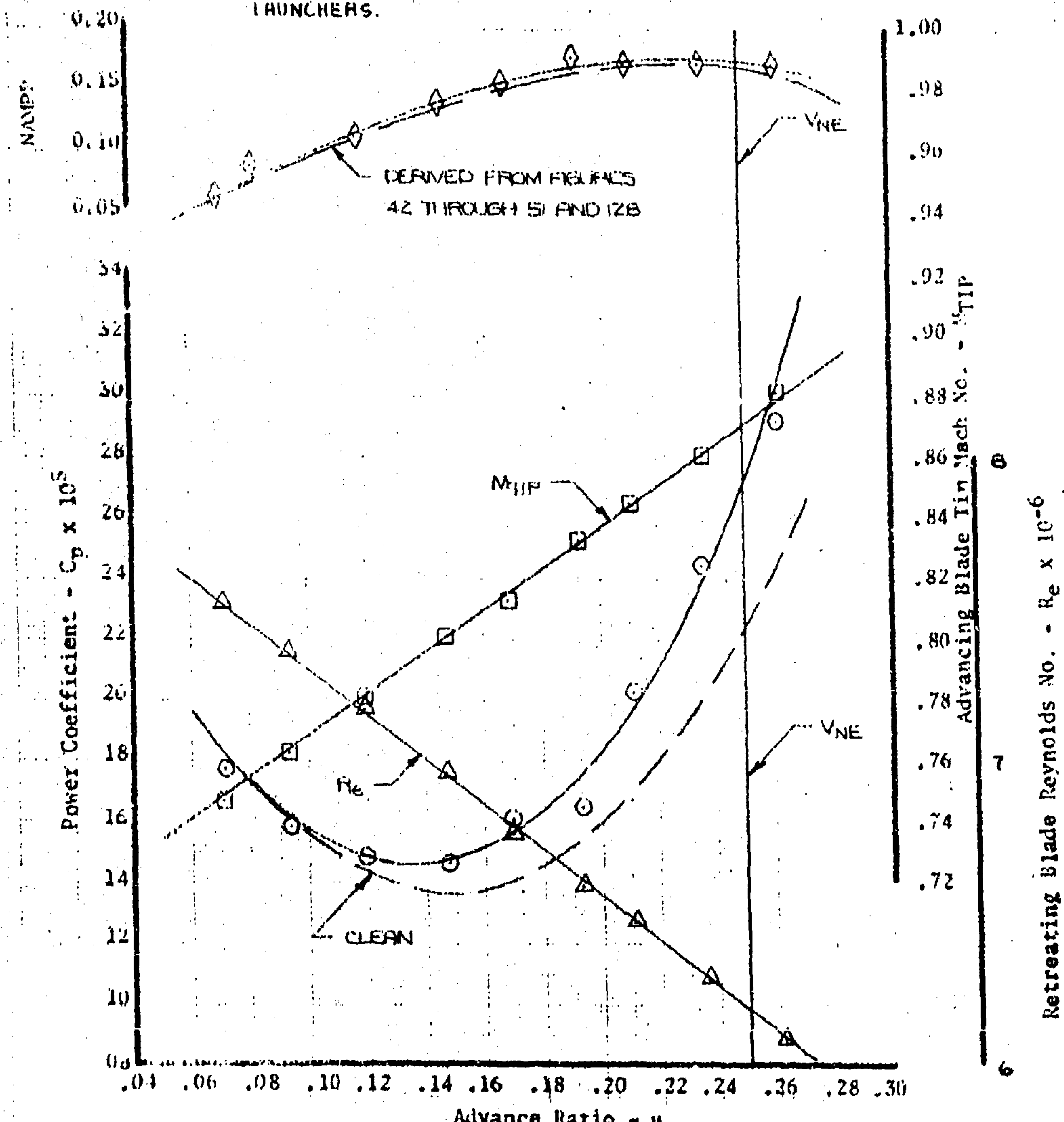


Figure 77. Nondimensional Level Flight Performance

OH-1H USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 15
C_T = 0.003...
W/δ_a = 11,050
$N_R/\sqrt{\theta_a}$ = 330.4
Avg N_R (rpm) = 318.6
Loading = CLEAN

Avg Pressure Altitude (Ft) = 7,200
Avg Free Air Temp. (°C) = -0.5
Avg Gross Weight (Lb) = 8510
Avg cg Location (Sta) = 135.6

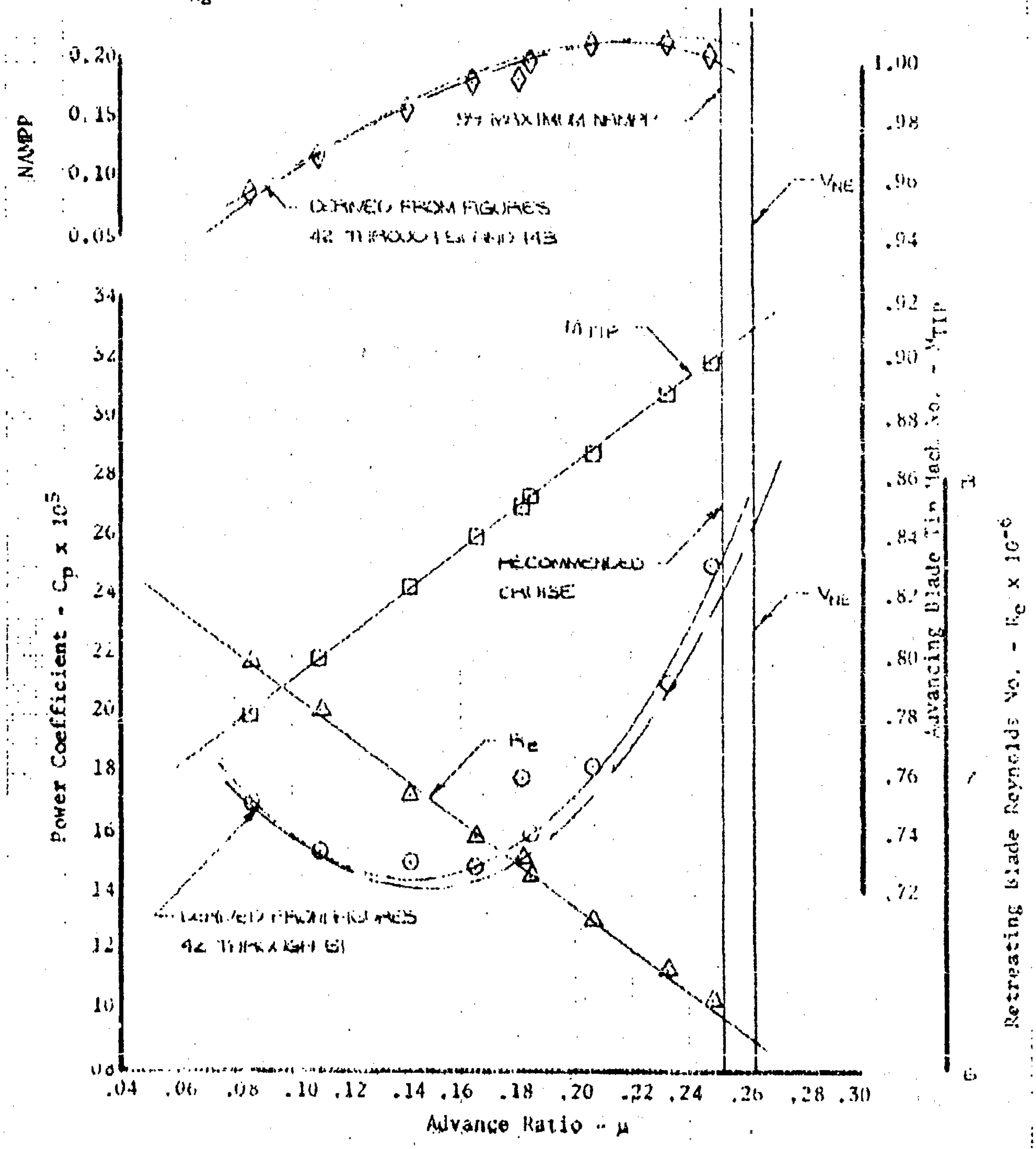


Figure 78 Nondimensional Level Flight Performance

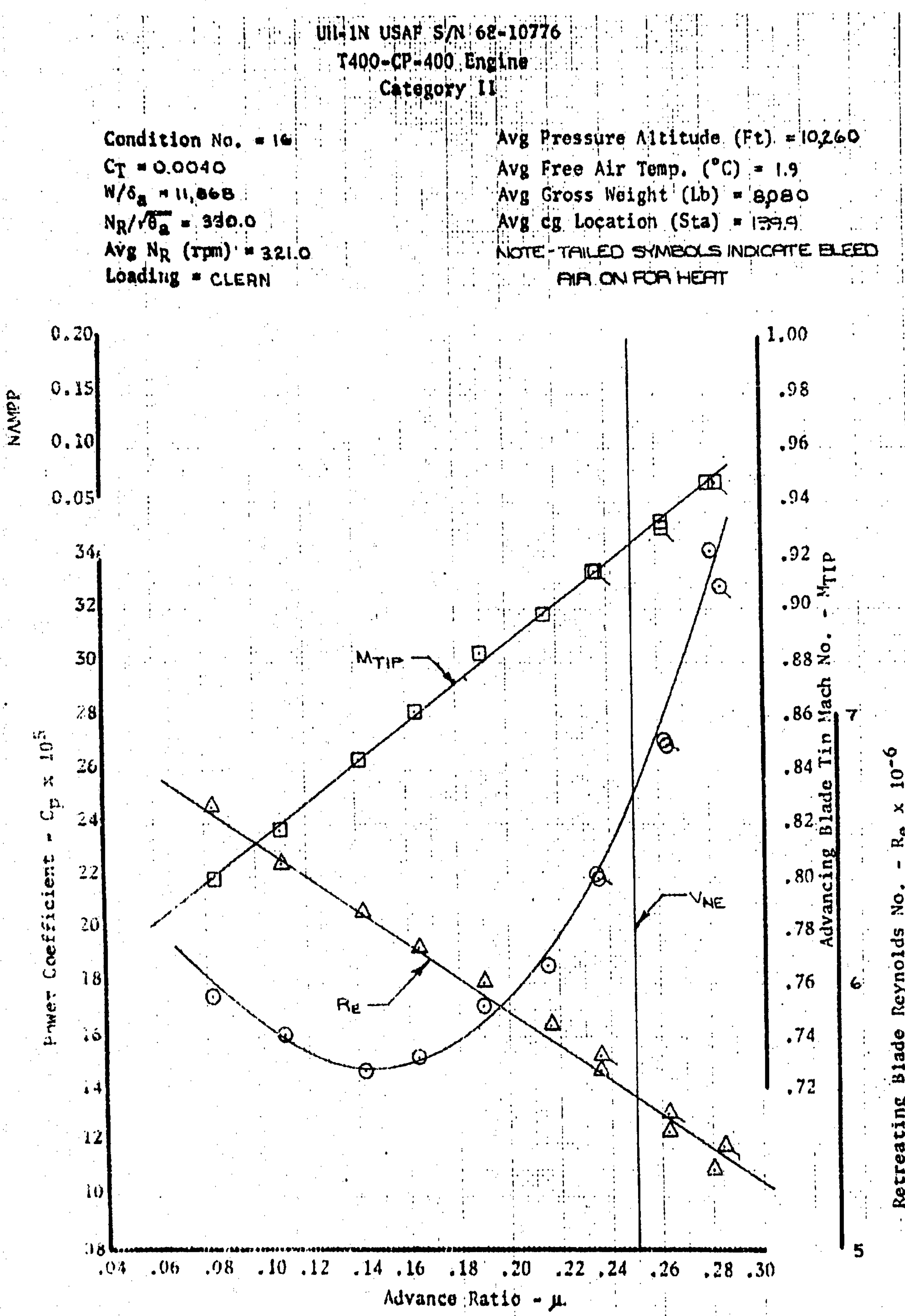


Figure 79. Nondimensional Level Flight Performance

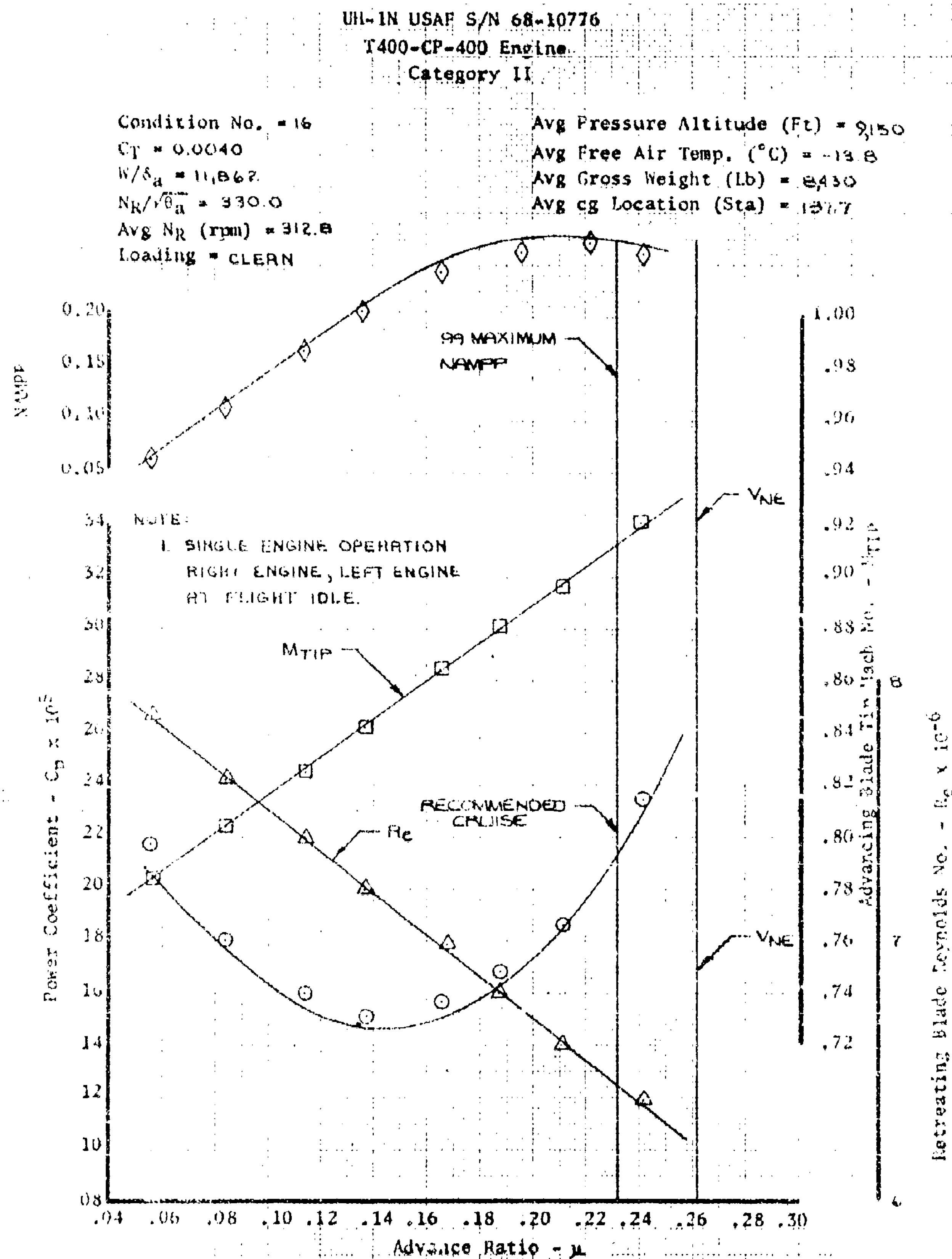


Figure 80. Nondimensional Level Flight Performance

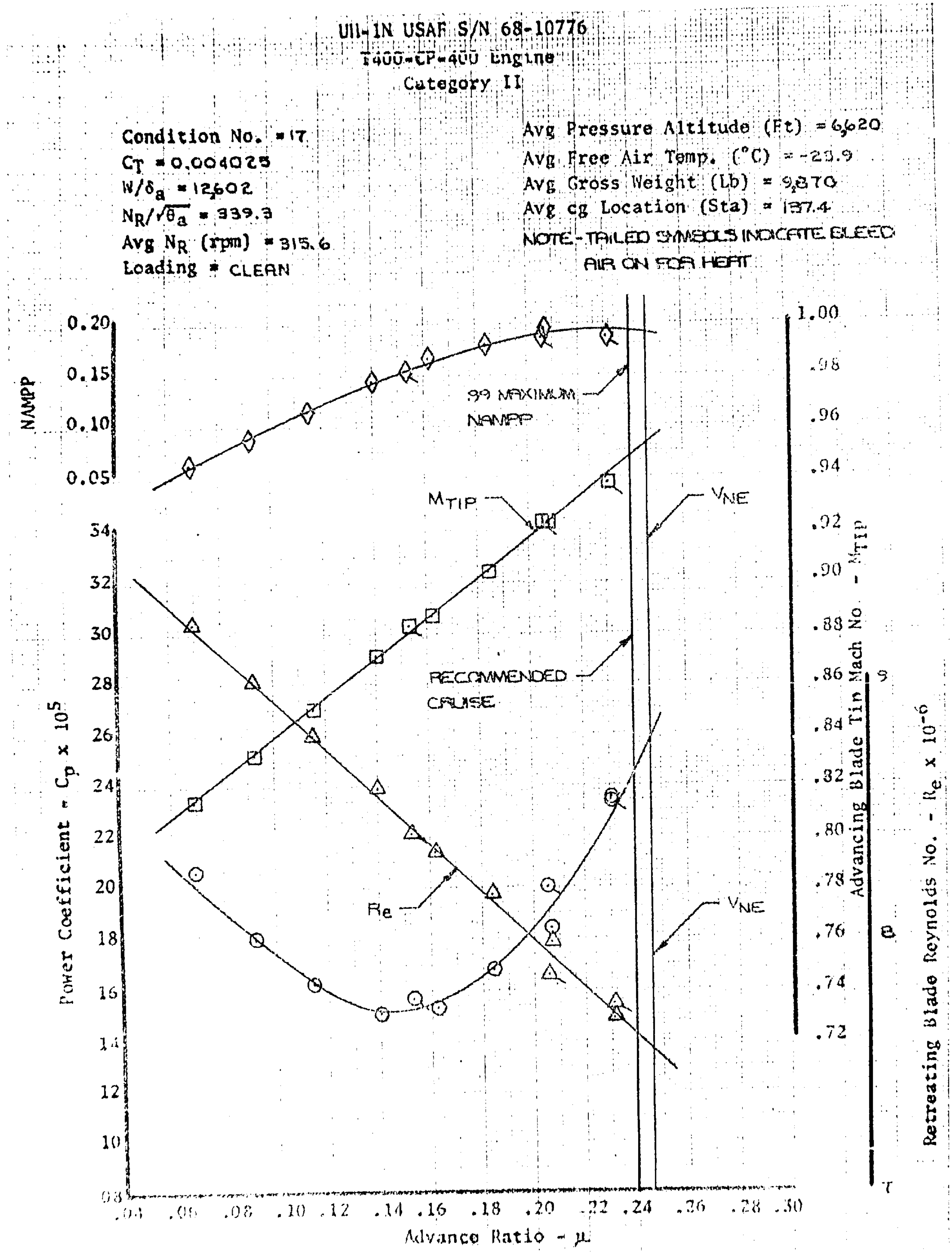


Figure 61. Nondimensional Level Flight Performance

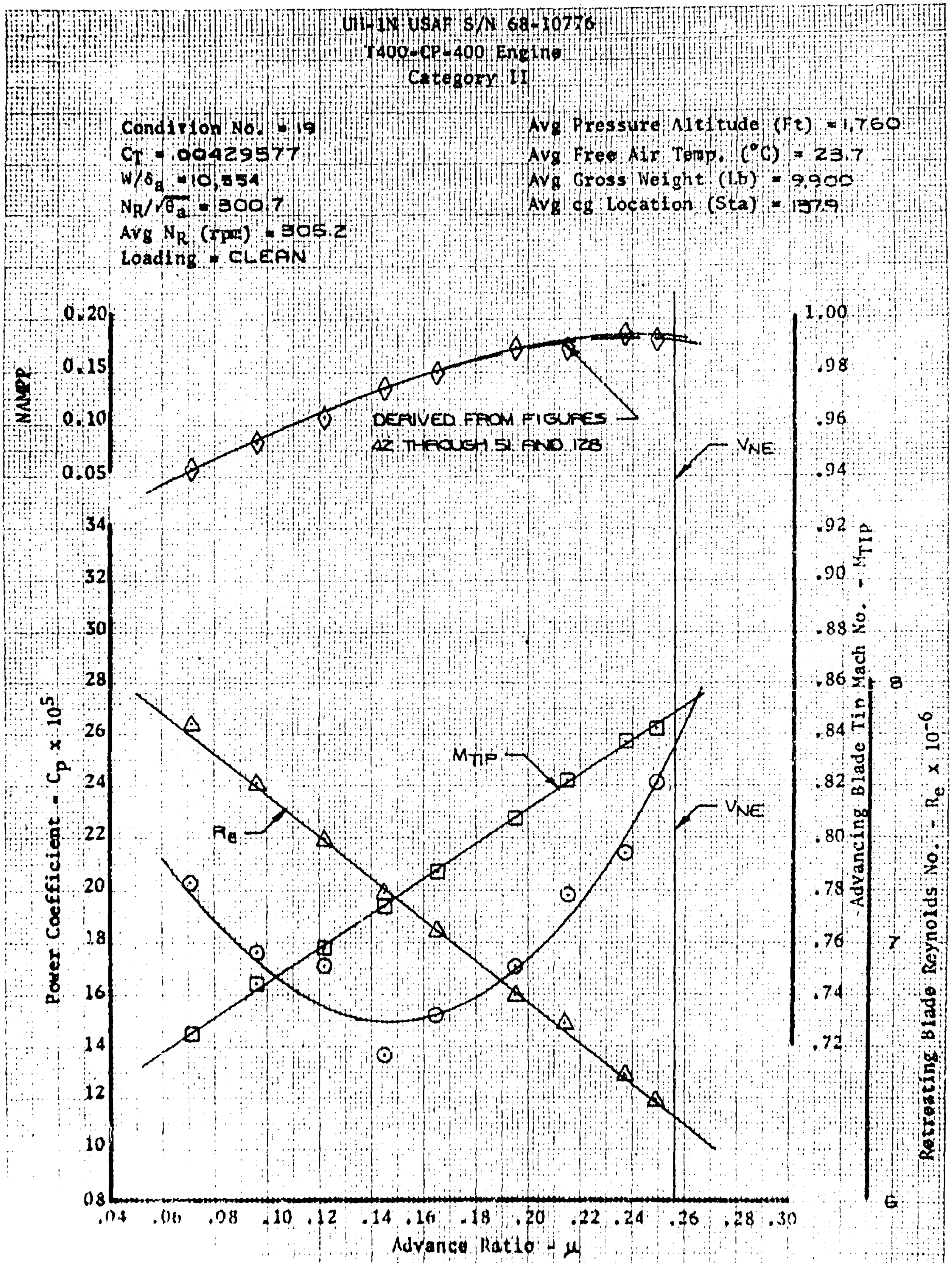


Figure 82. Nondimensional Level Flight Performance

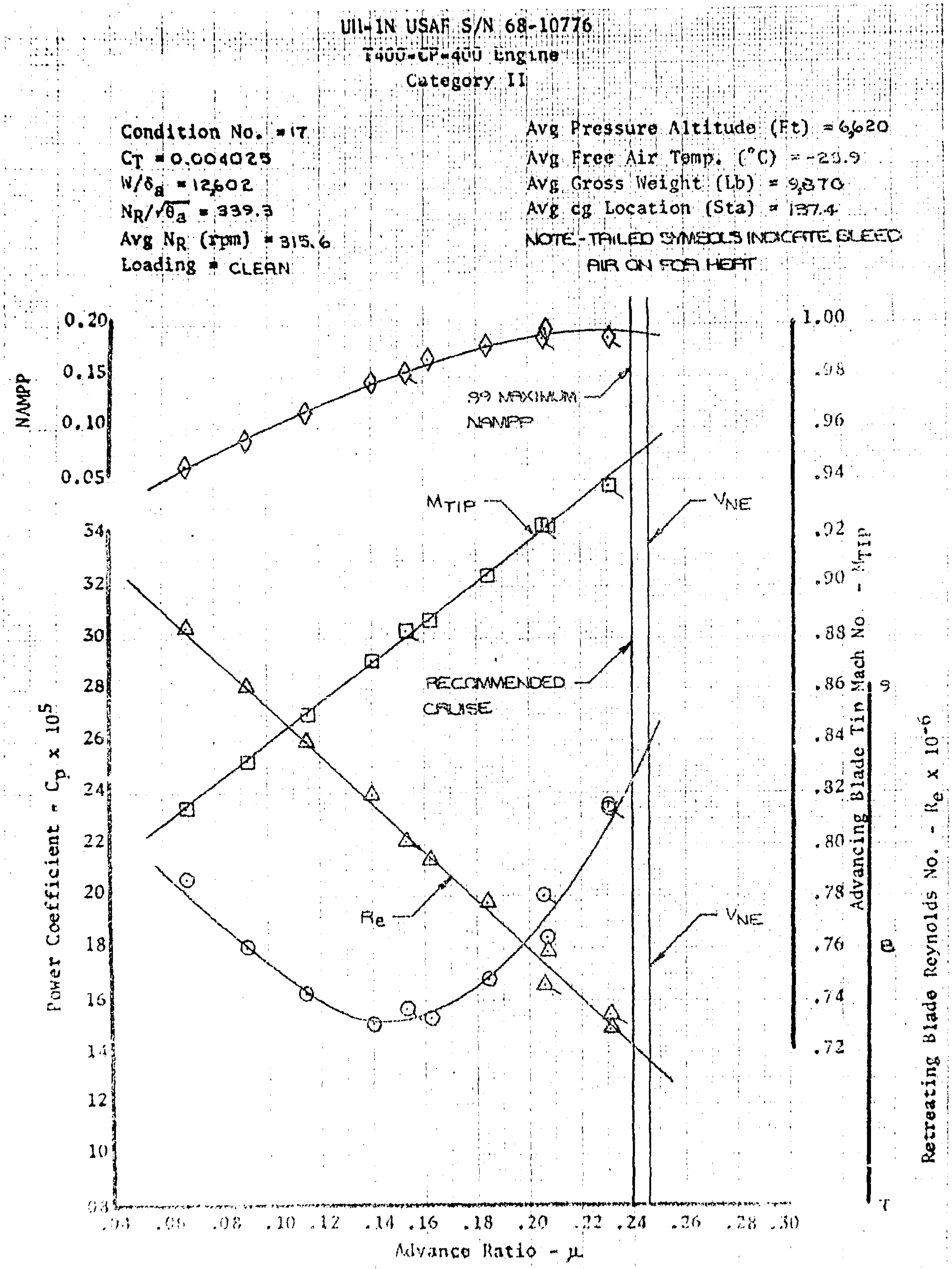


Figure 61. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 20
C_T = 0.0042795
W/δ_a = 11,224
$N_R/\sqrt{\theta_a}$ = 310.7
Avg N_R (rpm) = 312.5
Loading = CLEAN

Avg Pressure Altitude (Ft) = 5450
Avg Free Air Temp. (°C) = 18.3
Avg Gross Weight (Lb) = 9,180
Avg cg Location (Sta) = 136.3

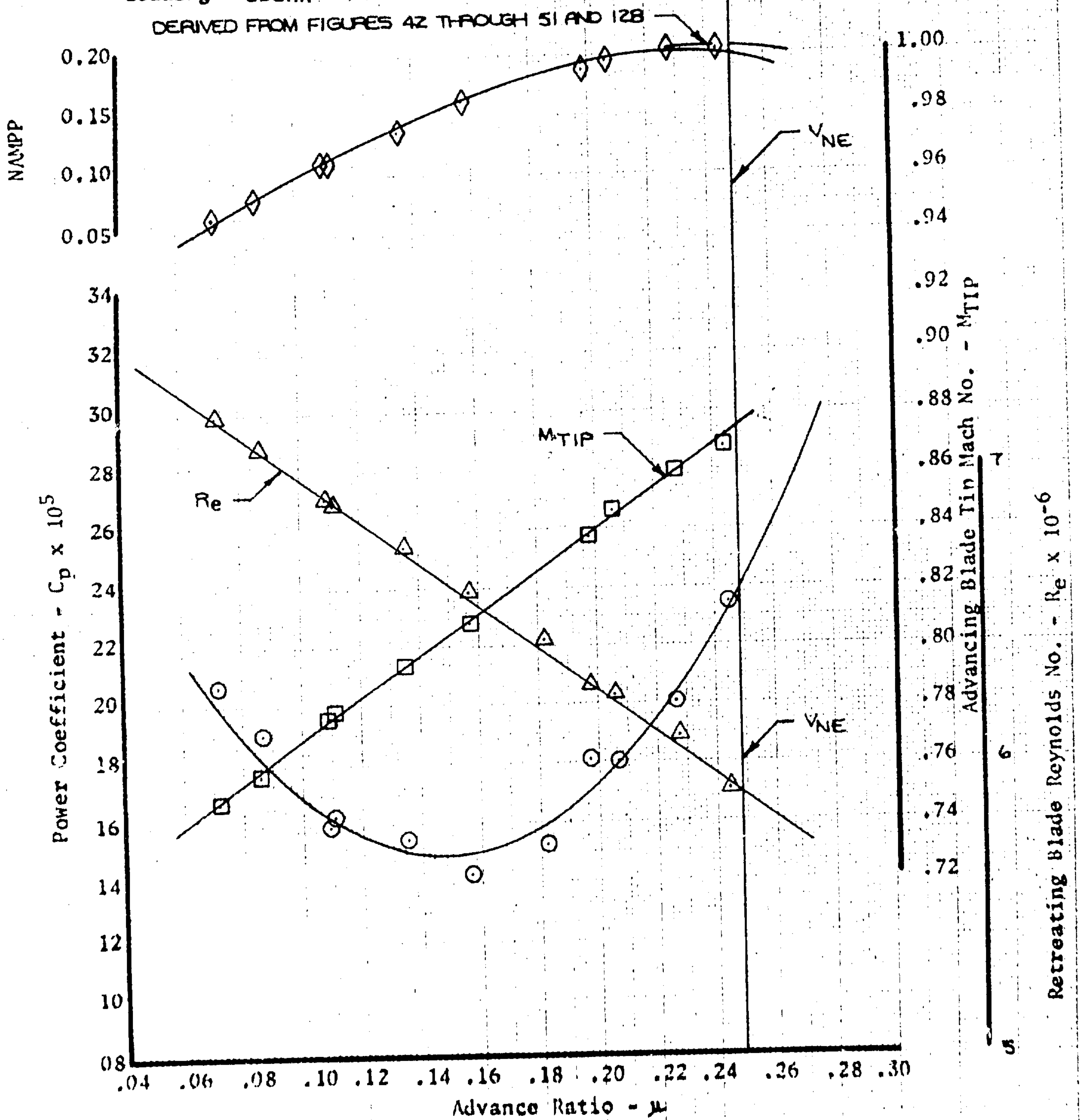


Figure 83. Nondimensional Level Flight Performance

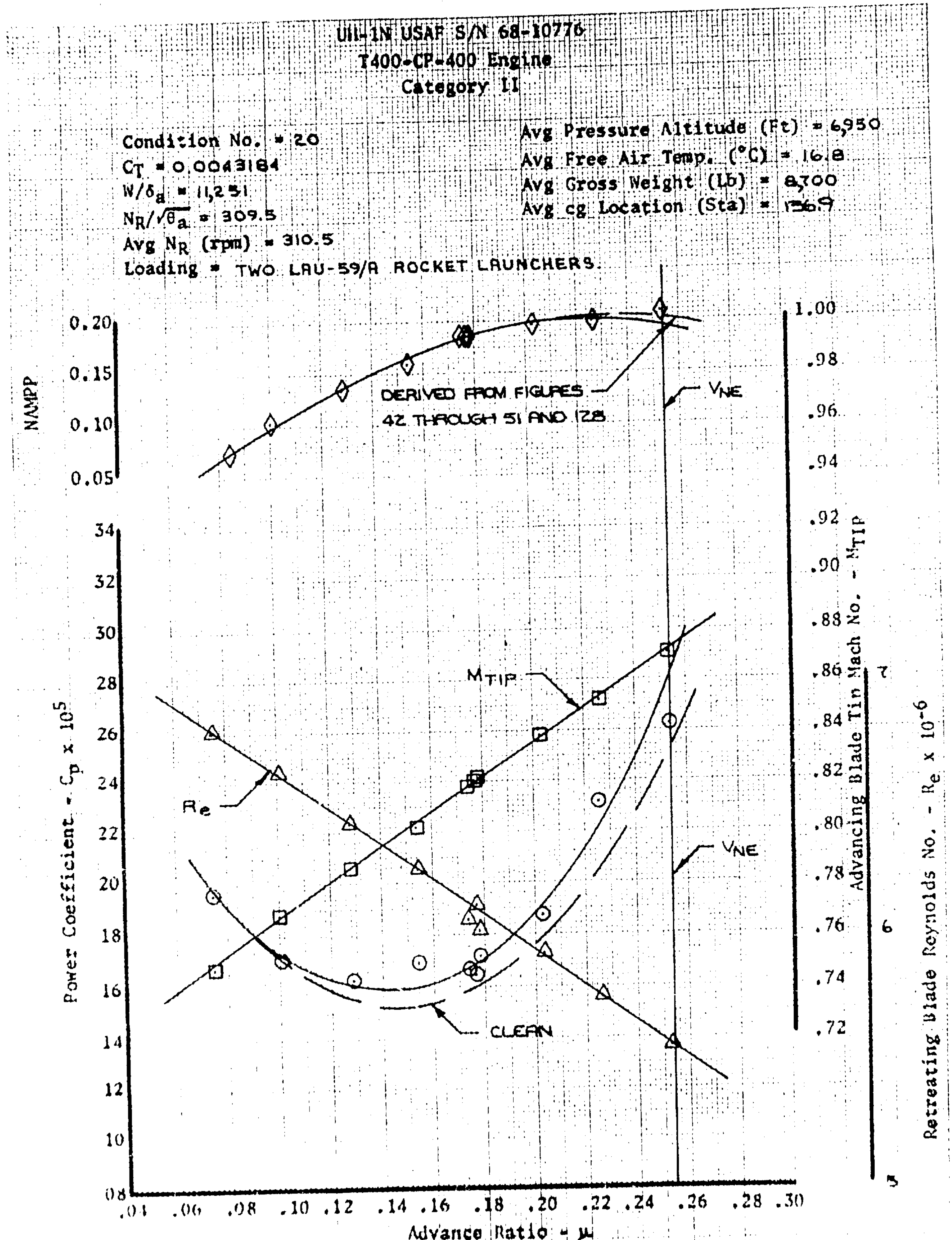


Figure 84. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 20
C_T = 0.0042998
W/δ_a = 11248
$N_R/\sqrt{\theta_a}$ = 310.3
Avg N_R (rpm) = 316.8
Loading = CARGO DOORS OPEN, TWO XM-93 MINIGUNS EXTENDED FIXED TO FIRE FORWARD, AND TWO LAU-59/A ROCKET LAUNCHERS

Avg Pressure Altitude (Ft) = 4130
Avg Free Air Temp. (°C) = 24.8
Avg Gross Weight (Lb) = 9480
Avg cg Location (Sta) = 137.2

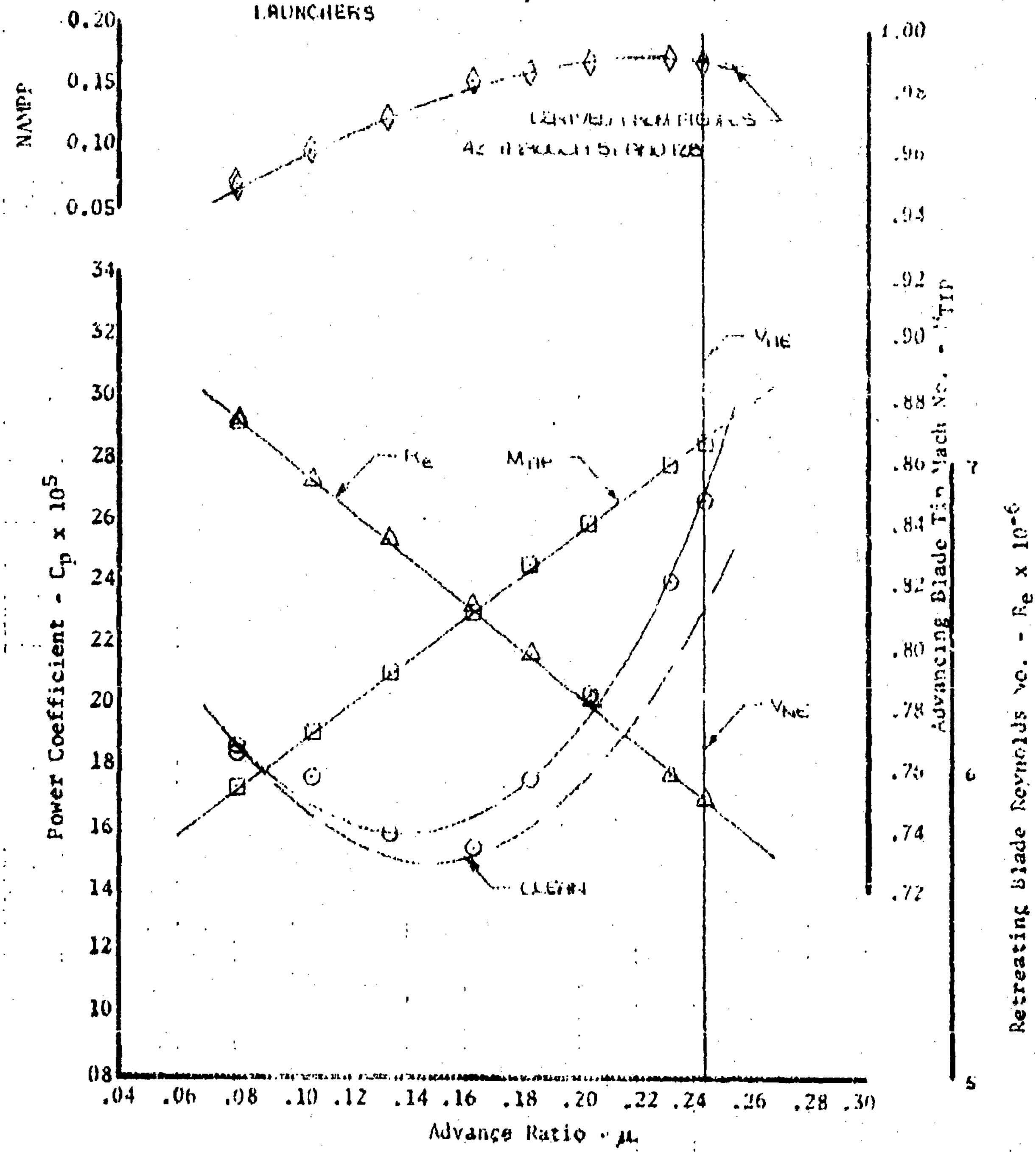


Figure 86. Nondimensional Level Flight Performance

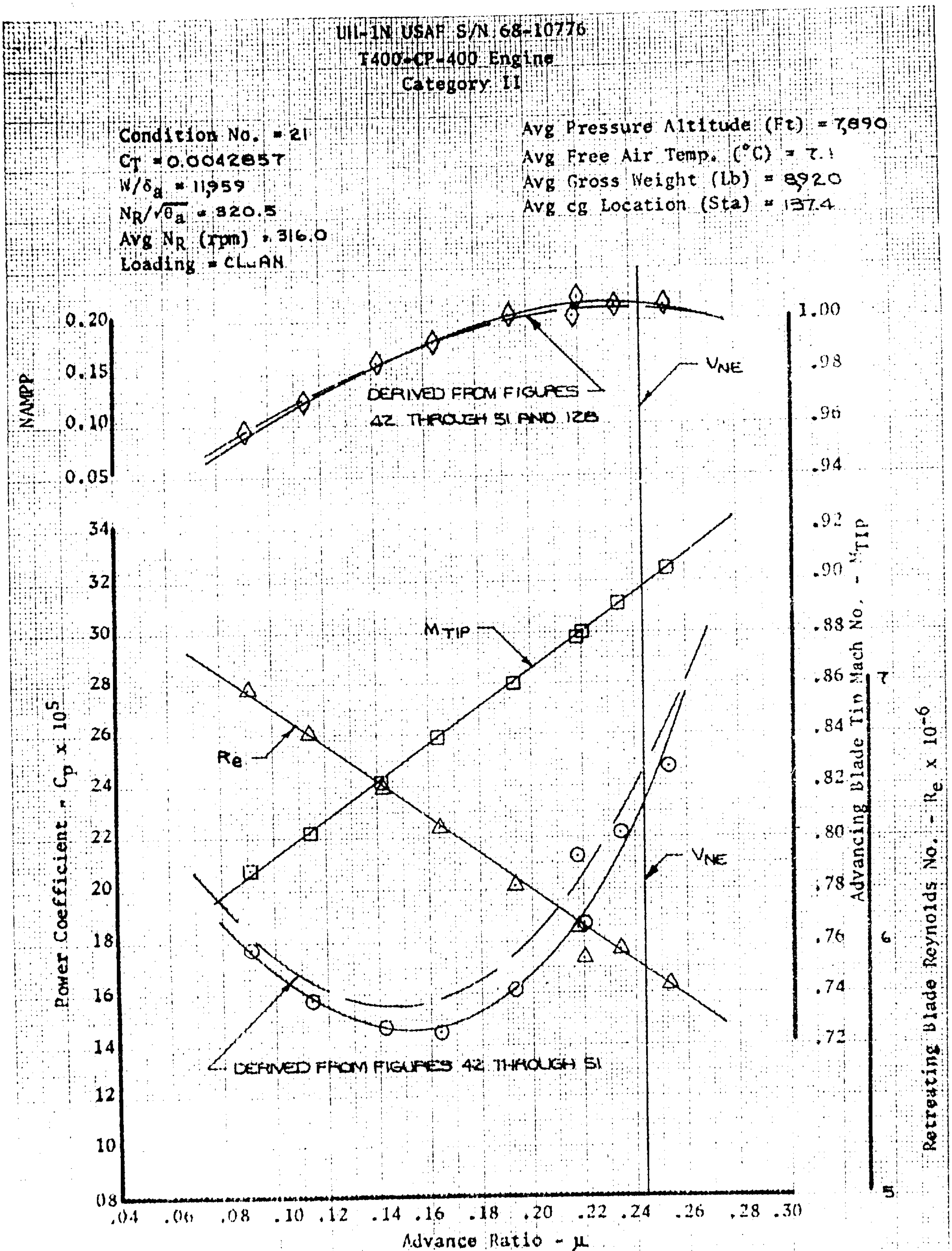


Figure 86. Nondimensional Level Flight Performance

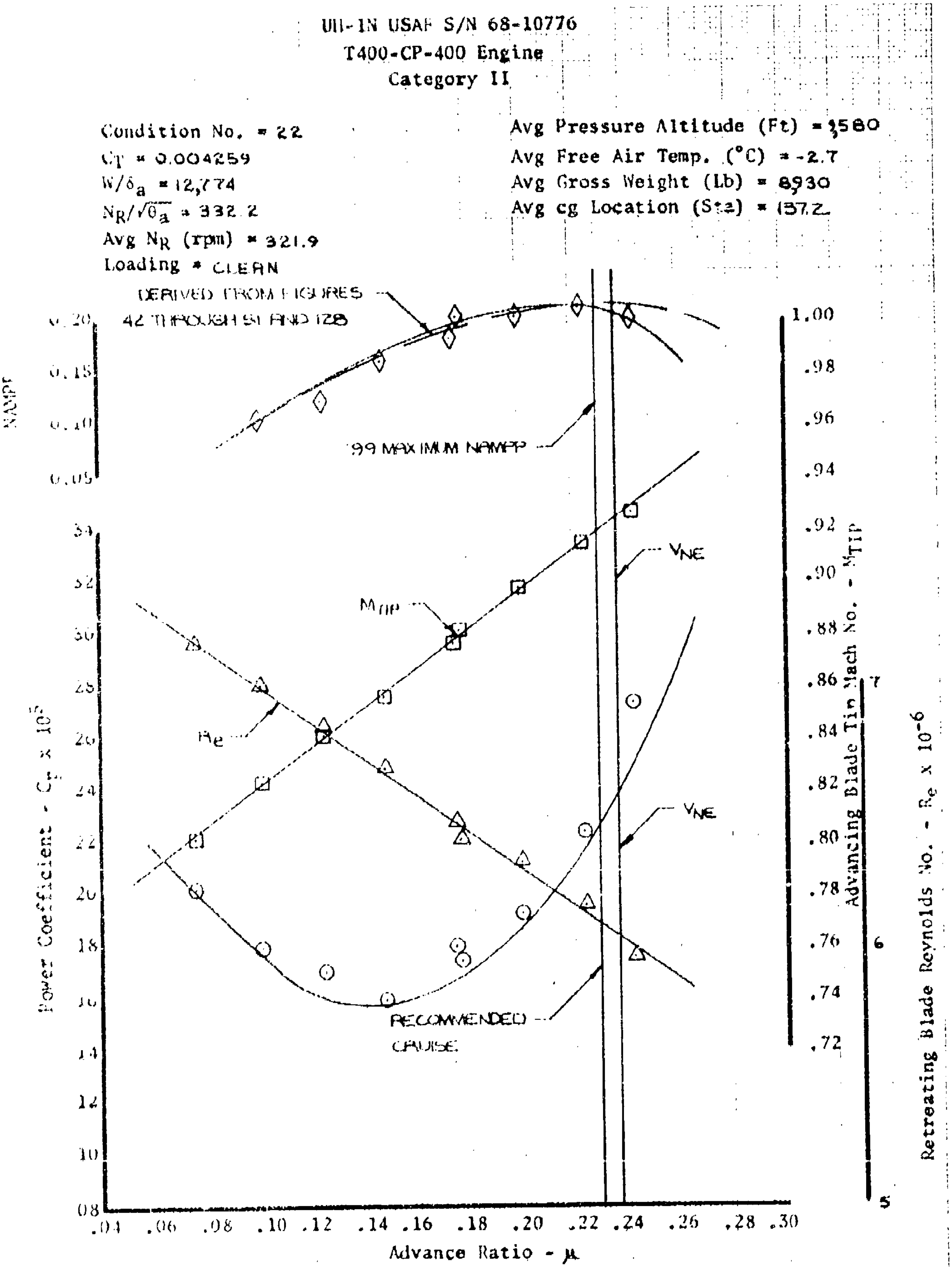


Figure 87. Nondimensional Level Flight Performance

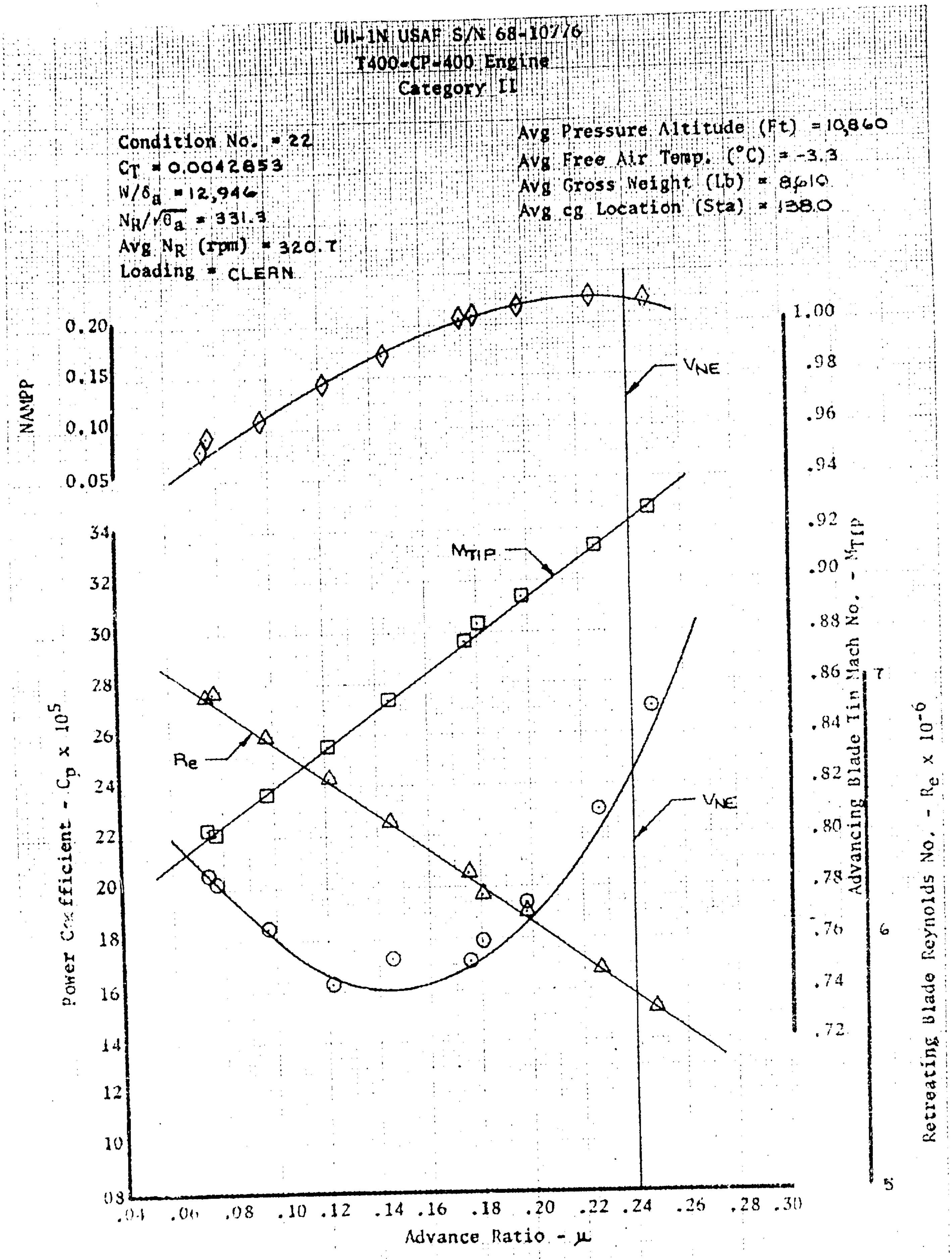


Figure 88. Nondimensional Level Flight Performance

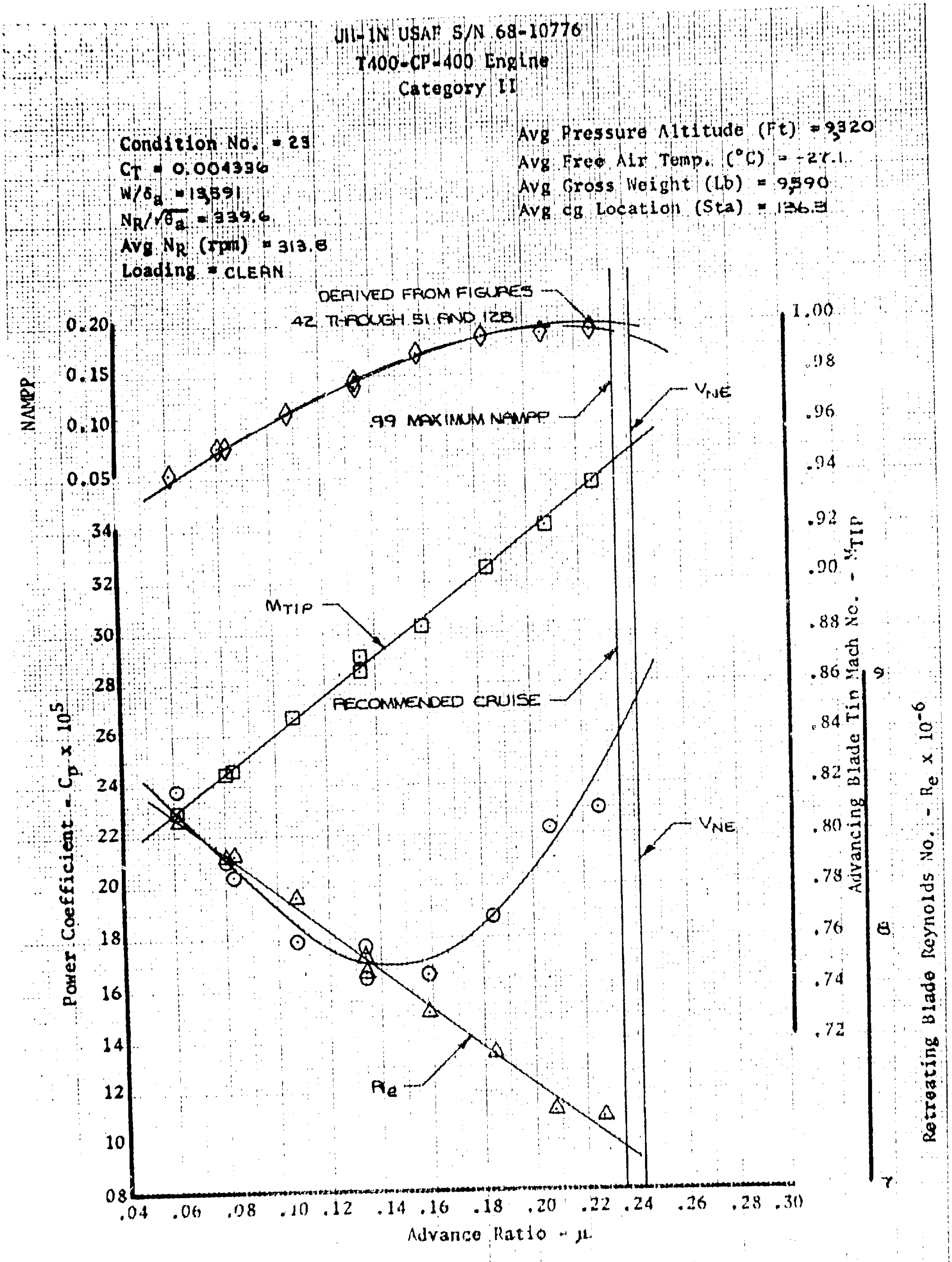


Figure 89. Nondimensional Level Flight Performance

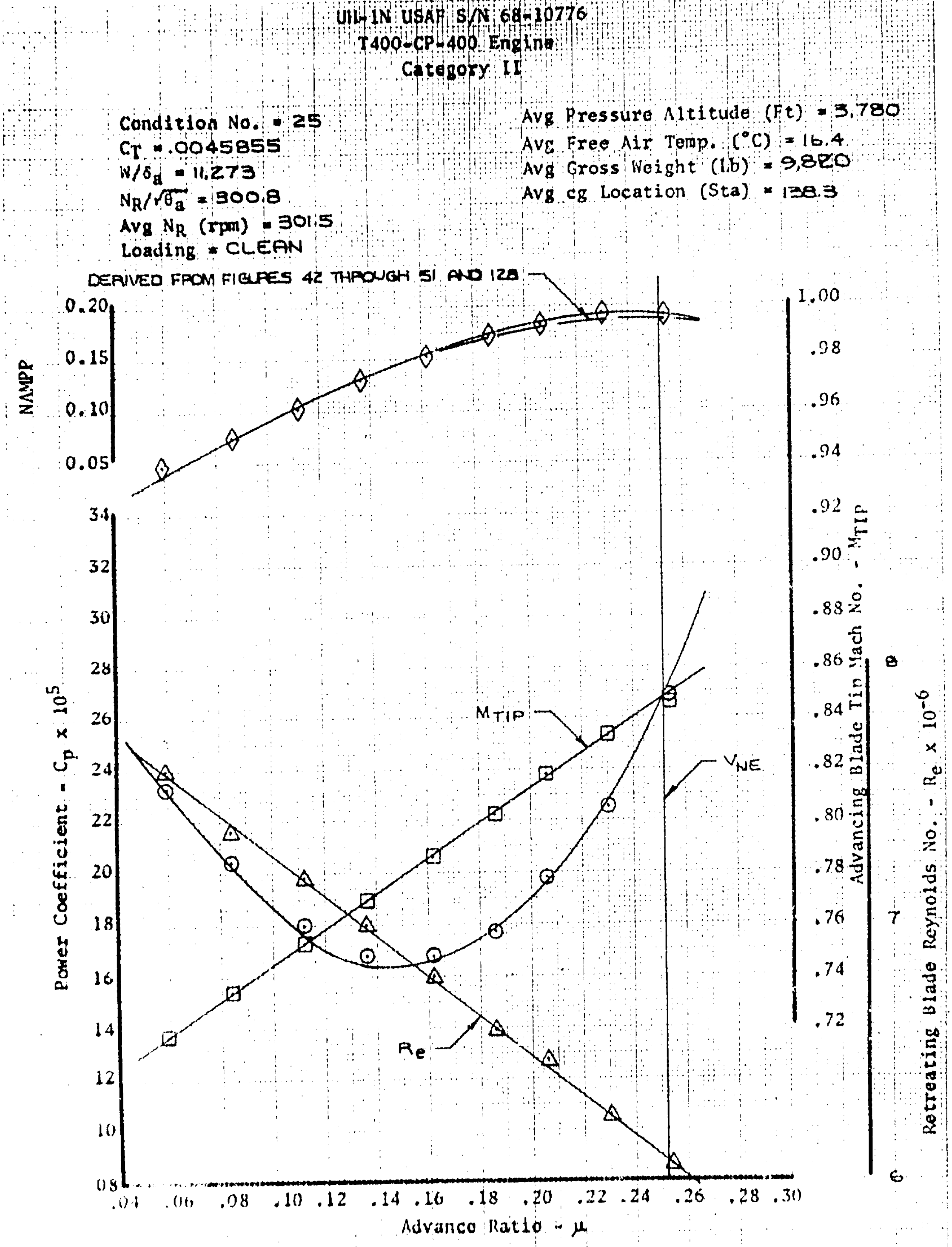


Figure 90. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 26
C_T = 0.0046099
W/δ_a = 12,022
$N_R/\sqrt{\theta_a}$ = 309.7
Avg N_R (rpm) = 310.3
Loading = TWO LAU-59/A ROCKET LAUNCHERS

Avg Pressure Altitude (Ft) = 7,700
Avg Free Air Temp. (°C) = 16.1
Avg Gross Weight (Lb) = 9030
Avg cg Location (Sta) = 130.0

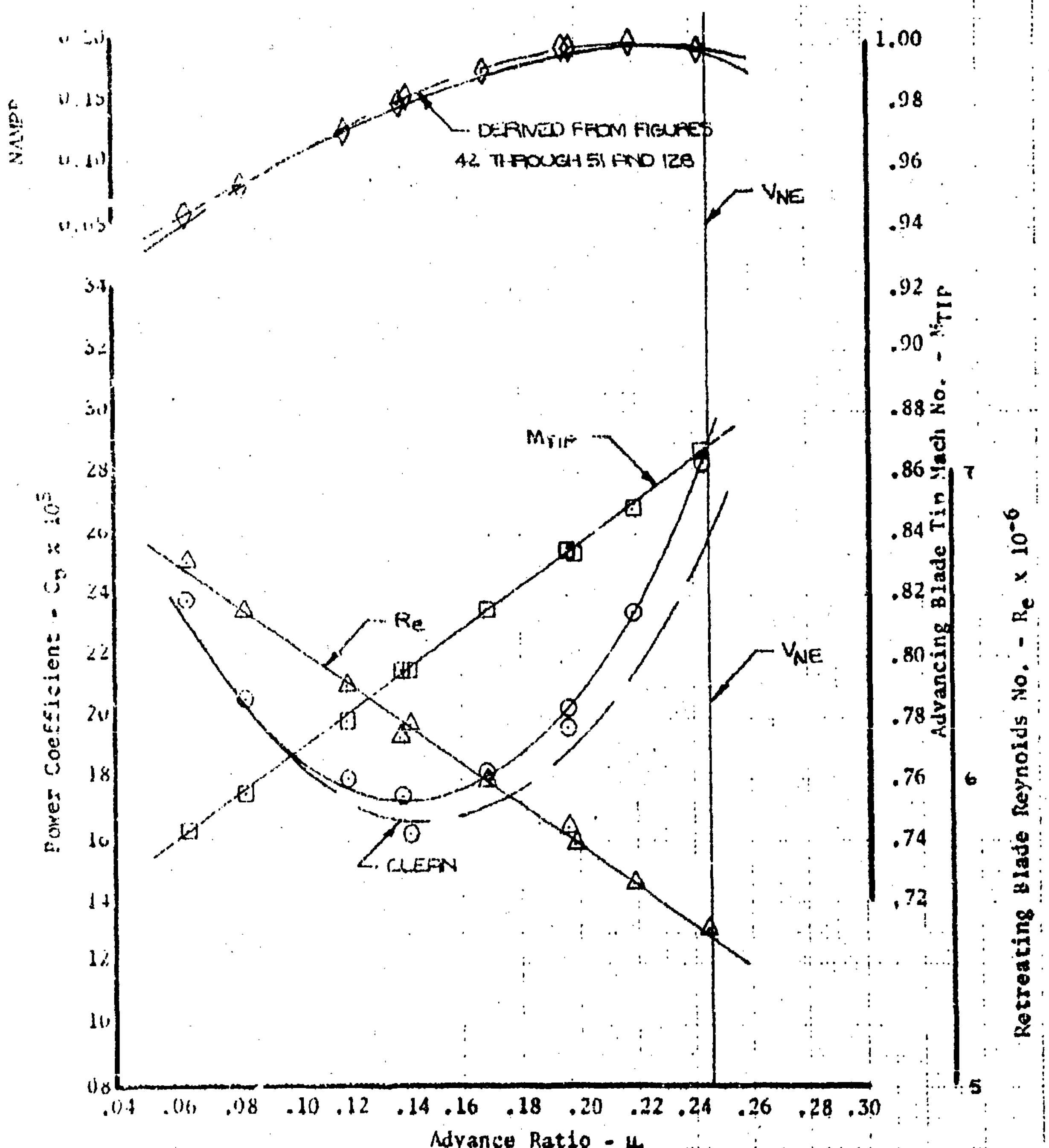


Figure 91. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 26
C_T = 0.004547
W/δ_a = 11,951
$N_R/\sqrt{\theta_a}$ = 310.9
Avg N_R (rpm) = 309.7
Loading = CARGO DOORS OPEN, TWO XM-93 MINIGUNS EXTENDED FIXED TO FIRE FORWARD, AND TWO LAU-59/A ROCKET LAUNCHERS.

Avg Pressure Altitude (Ft) = 6,120
Avg Free Air Temp. (°C) = 12.5
Avg Gross Weight (Lb) = 9,430
Avg cg Location (Sta) = 137.8

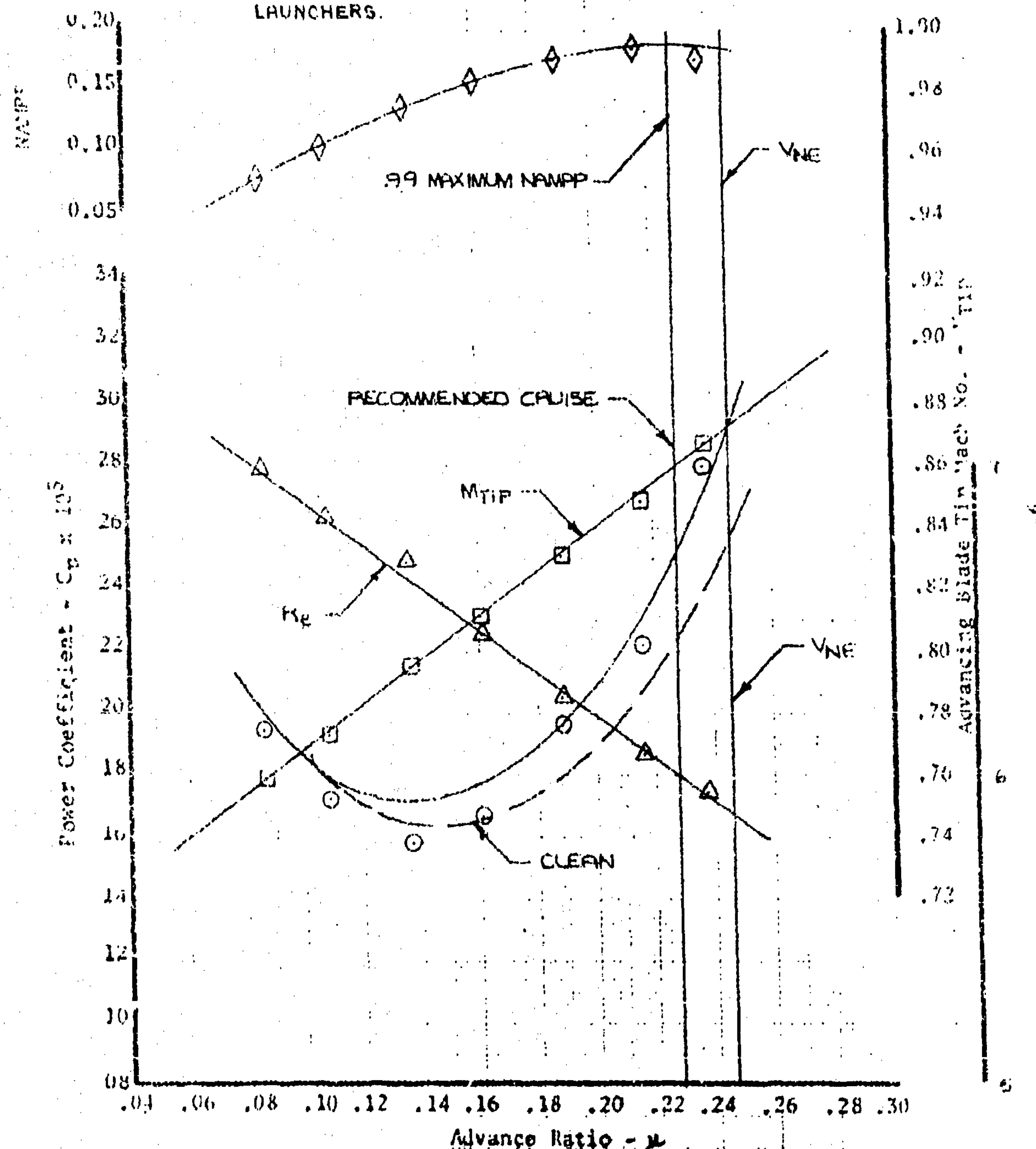


Figure 92. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 27
C_T = 0.0045857
W/δ_a = 12,808
$N_R/\sqrt{\theta_r}$ = 320.5
Avg N_R (rpm) = 310.7
Loading = CLEAN

Avg Pressure Altitude (Ft) = 9,790
Avg Free Air Temp. (°C) = -2.4
Avg Gross Weight (lb) = 8,880
Avg cg Location (Sta) = 137.0

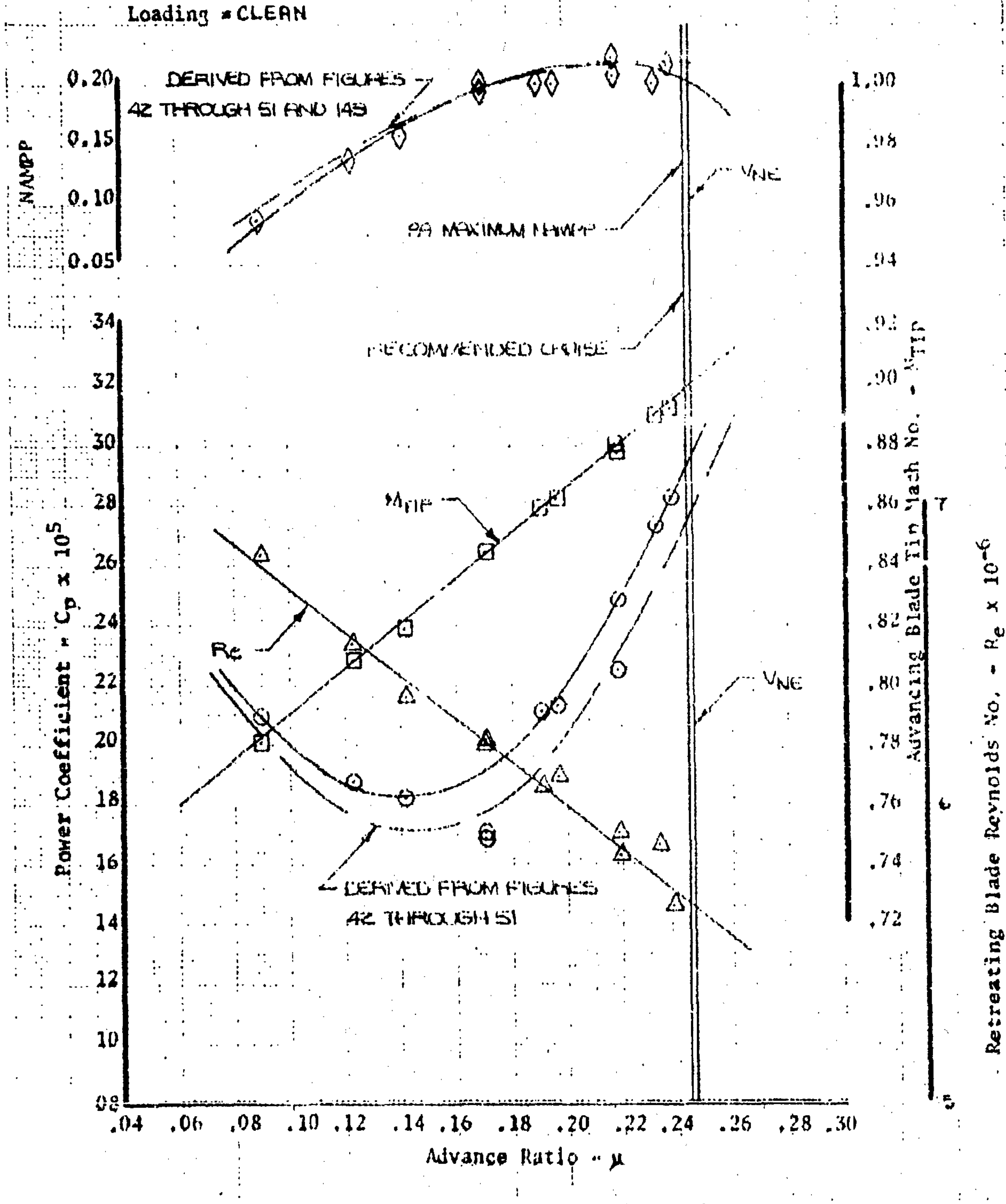


Figure 93. Nondimensional Level Flight Performance

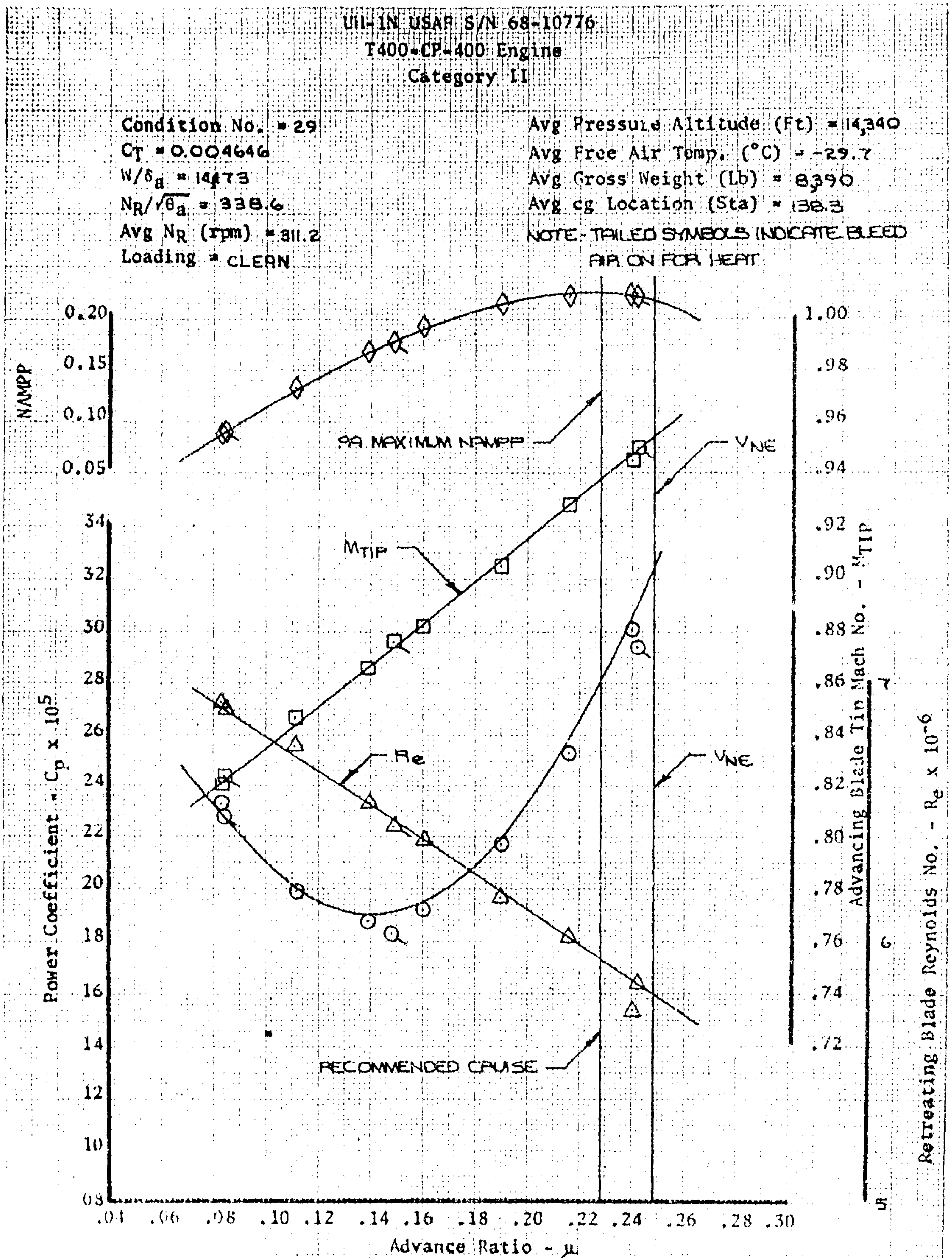


Figure 94. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 31
C_T = .0049981
W/δ_a = 12,249
$N_R/\sqrt{\theta_a}$ = 300.3
Avg N_R (rpm) = 301.7
Loading = CLEAN

Avg Pressure Altitude (Ft) = 5,850
Avg Free Air Temp. (°C) = 17.9
Avg Gross Weight (Lb) = 9,870
Avg cg Location (Sta) = 137.7

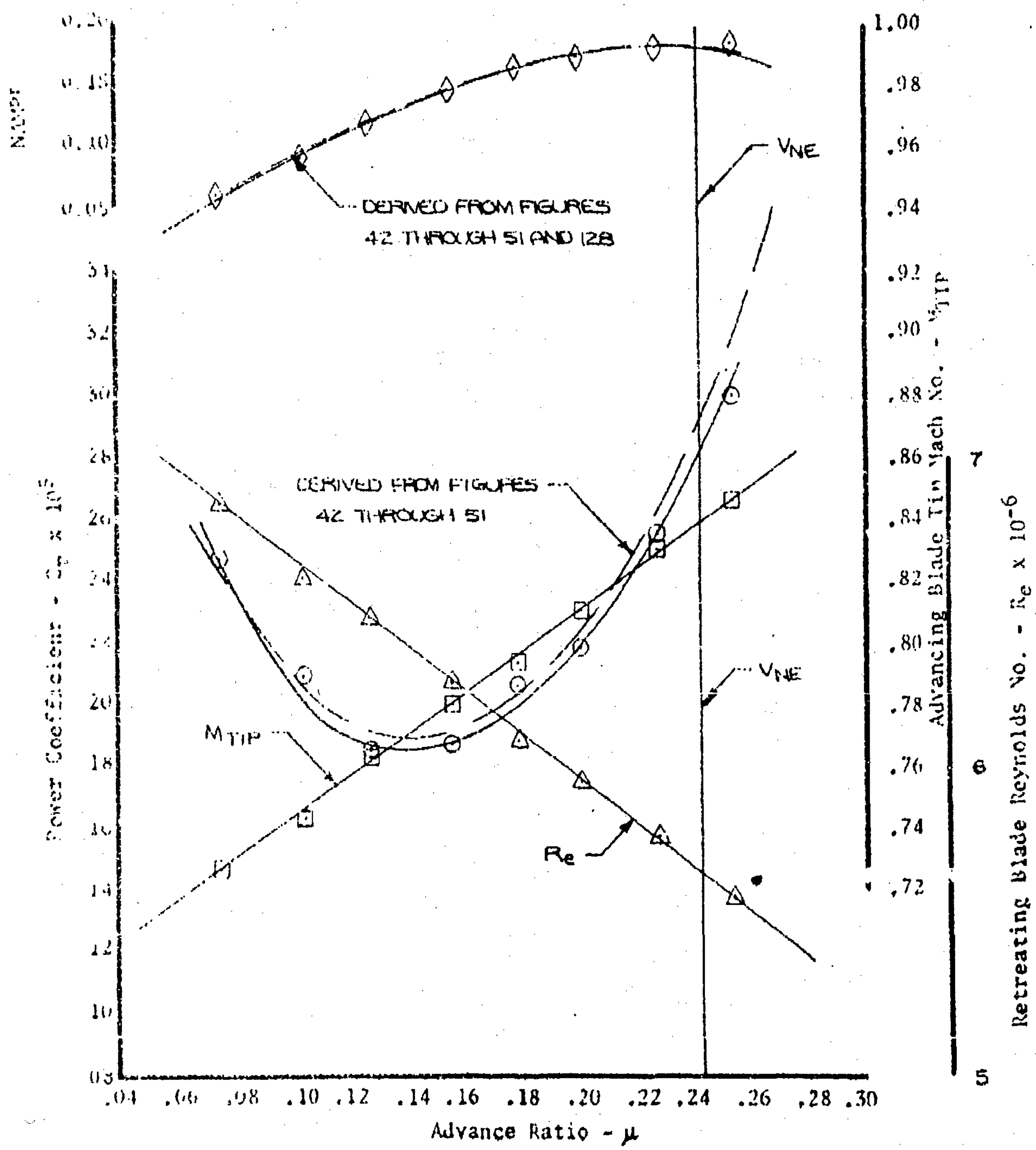


Figure 95. Nondimensional Level Flight Performance

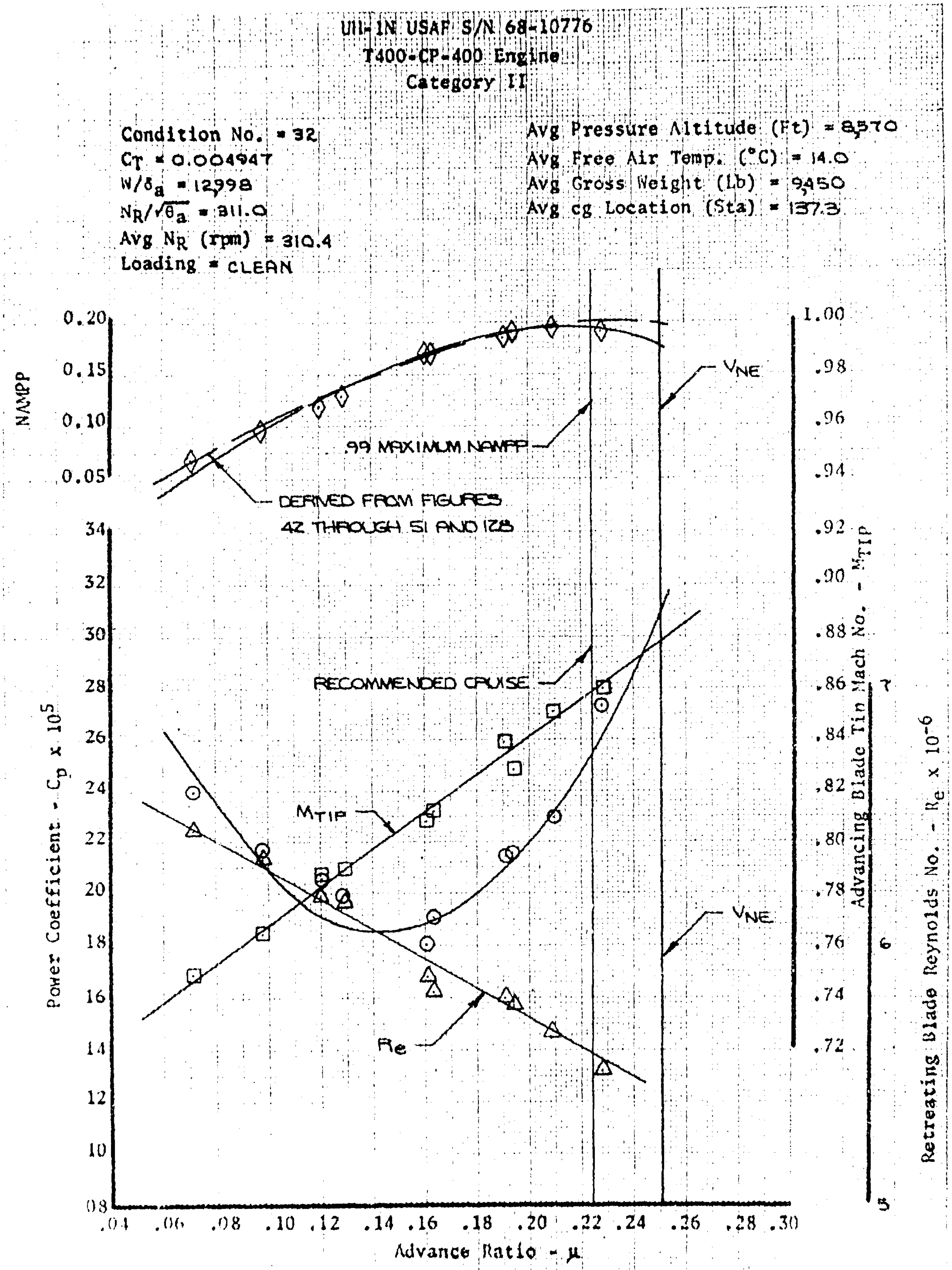


Figure 96. Nondimensional Level Flight Performance

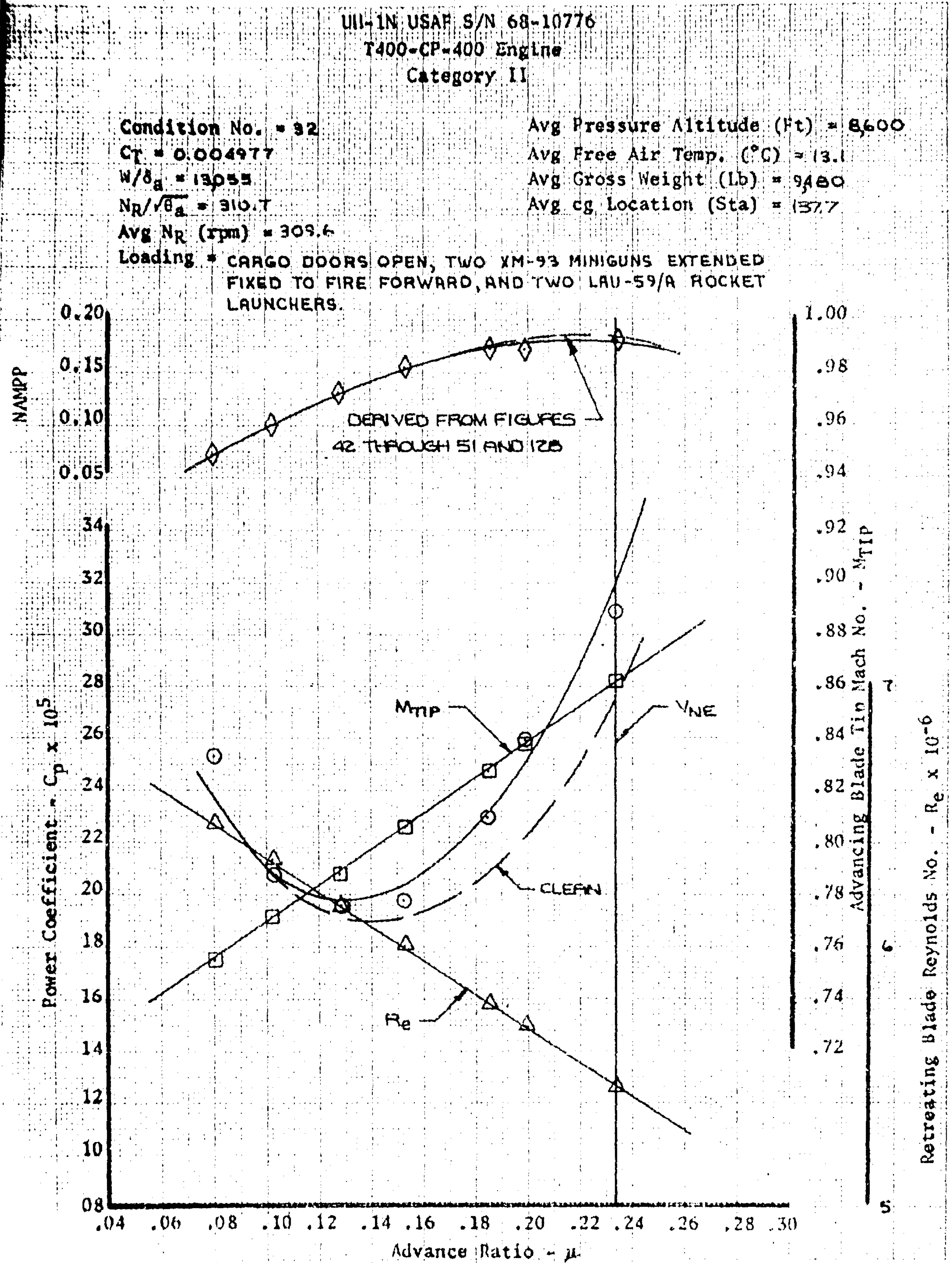


Figure 97. Nondimensional Level Flight Performance

UH-1N USAF S/N 68-10776
T400-CP-400 Engine
Category II

Condition No. = 33
C_T = 0.0049995
W/δ_a = 13857
$N_R/\sqrt{\theta_a}$ = 319.4
Avg N_R (rpm) = 315.5
Loading = CLEAN

Avg Pressure Altitude (Ft) = 11290
Avg Free Air Temp. (°C) = 8.1
Avg Gross Weight (lb) = 9060
Avg cg Location (Sta) = 135.9

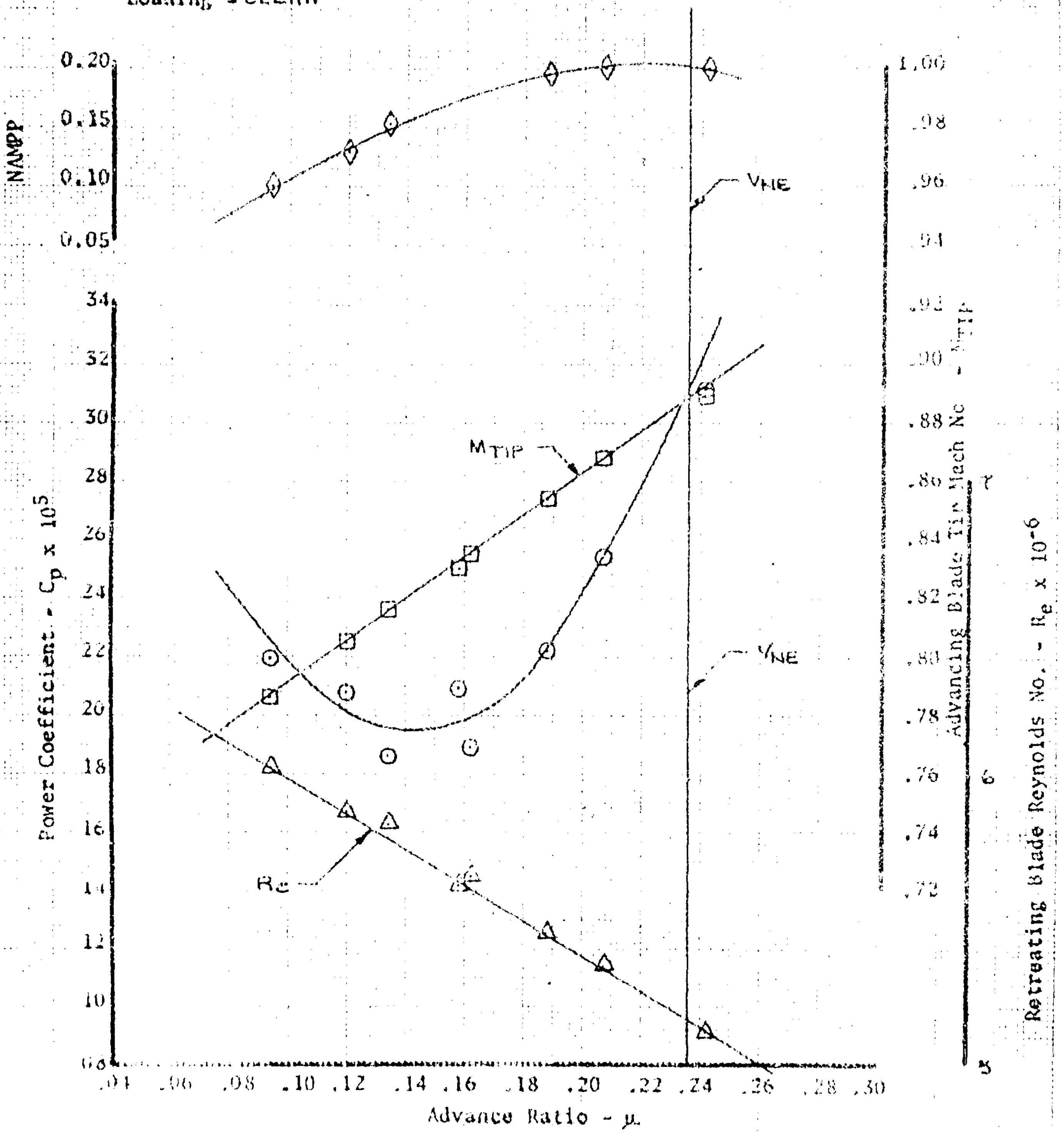


Figure 58 Nondimensional Level Flight Performance

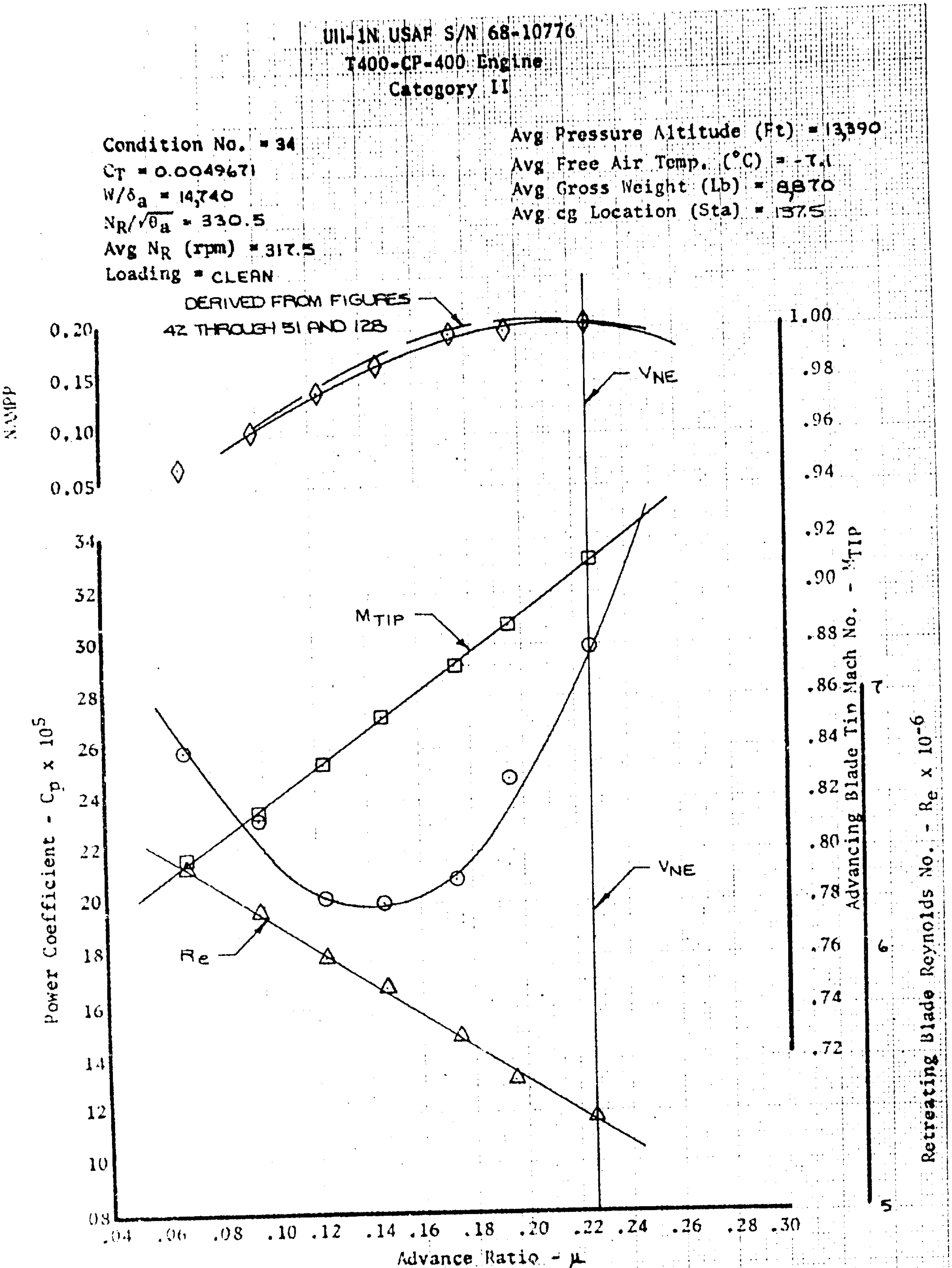


Figure 99. Nondimensional Level Flight Performance.

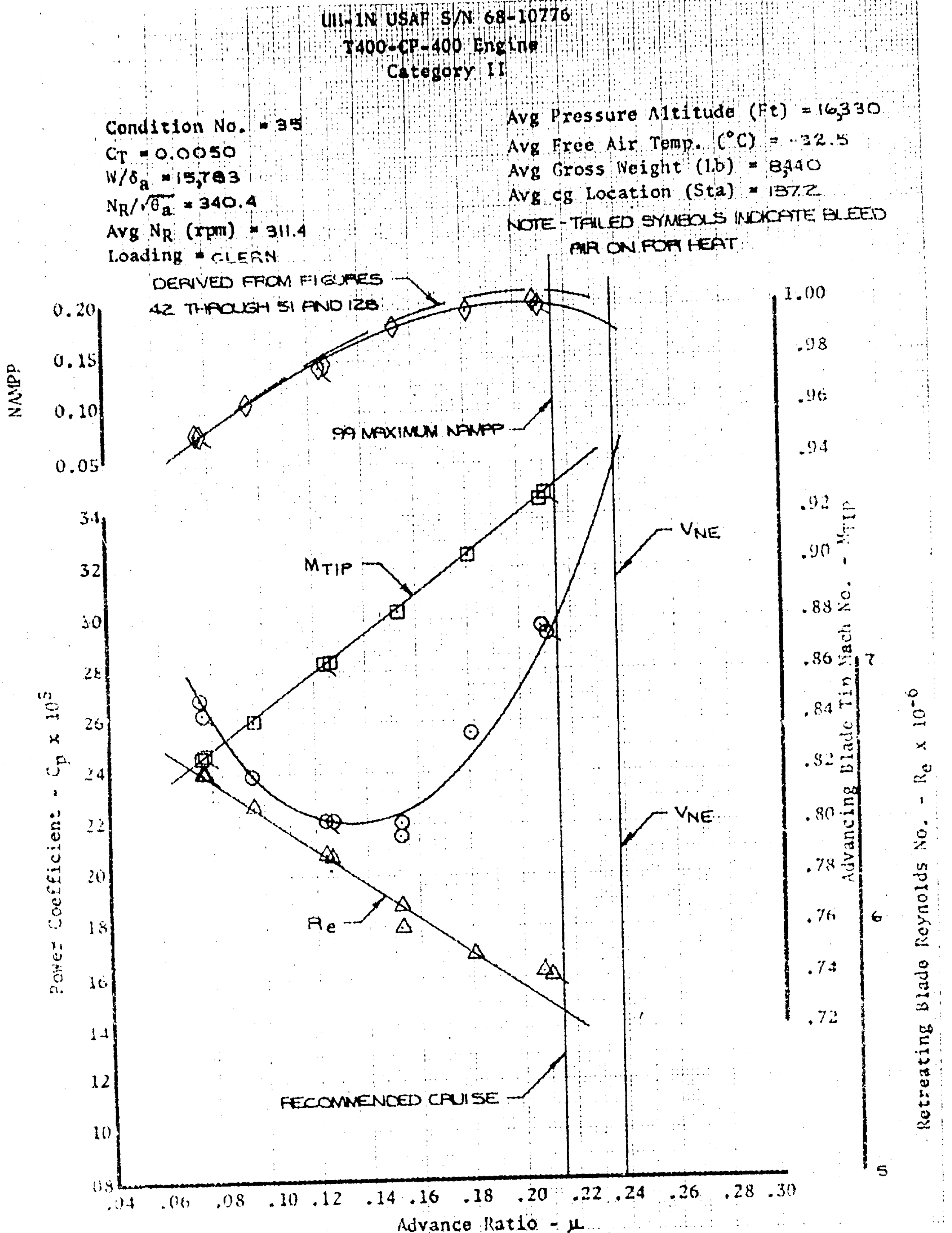


Figure 100. Nondimensional Level Flight Performance

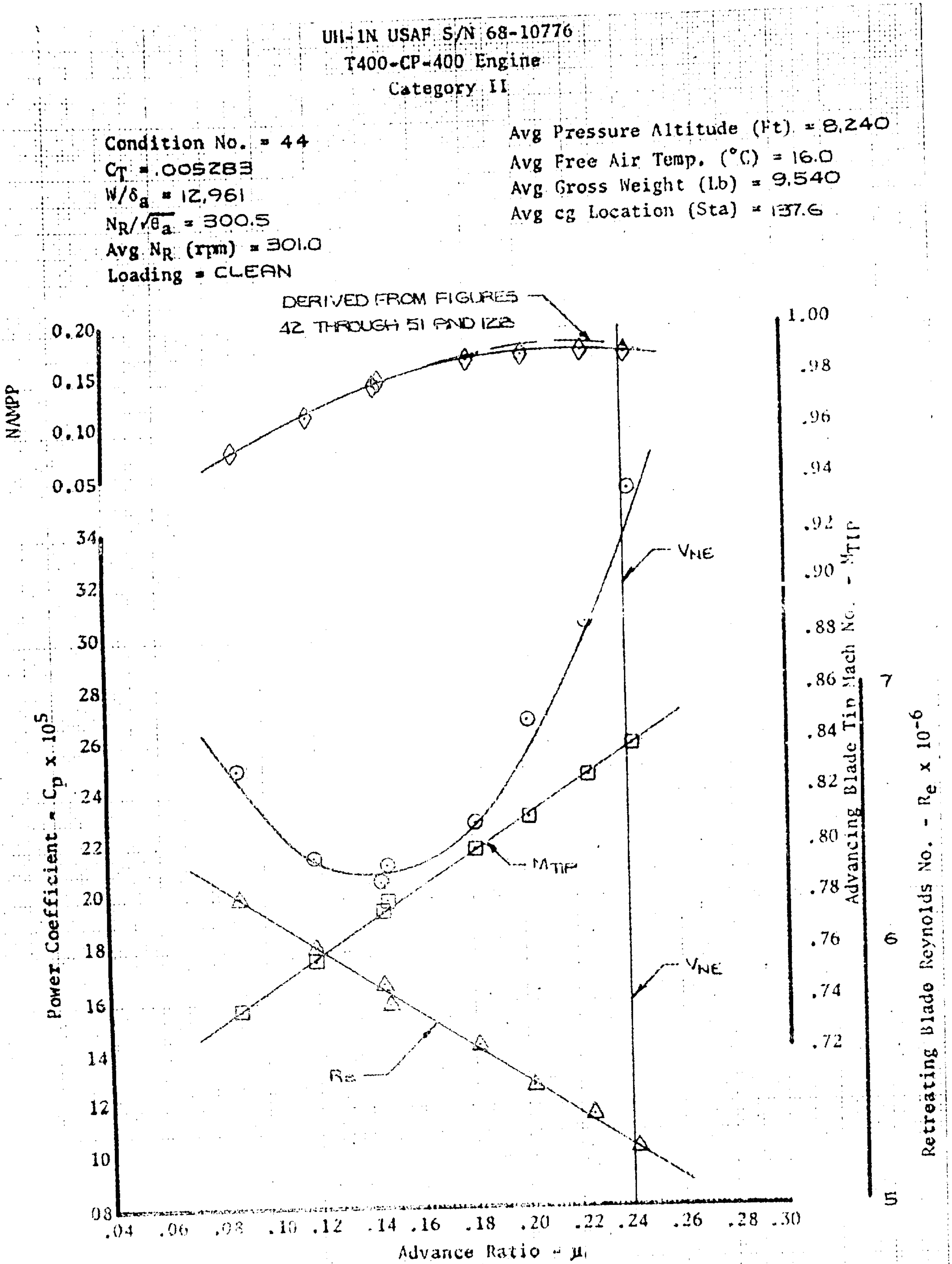


Figure 101. Nondimensional Level Flight Performance

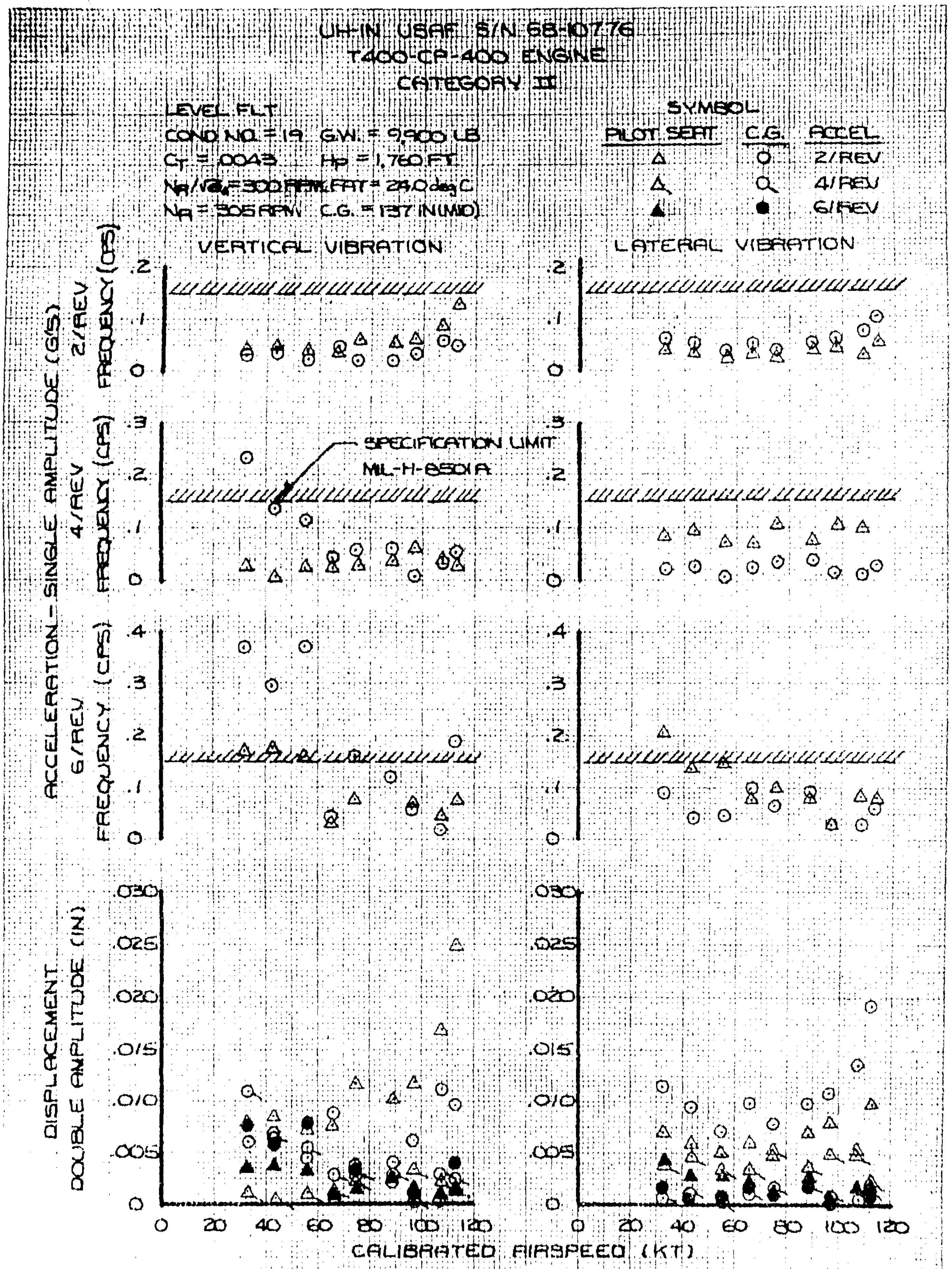


FIGURE 102 VIBRATION CHARACTERISTICS

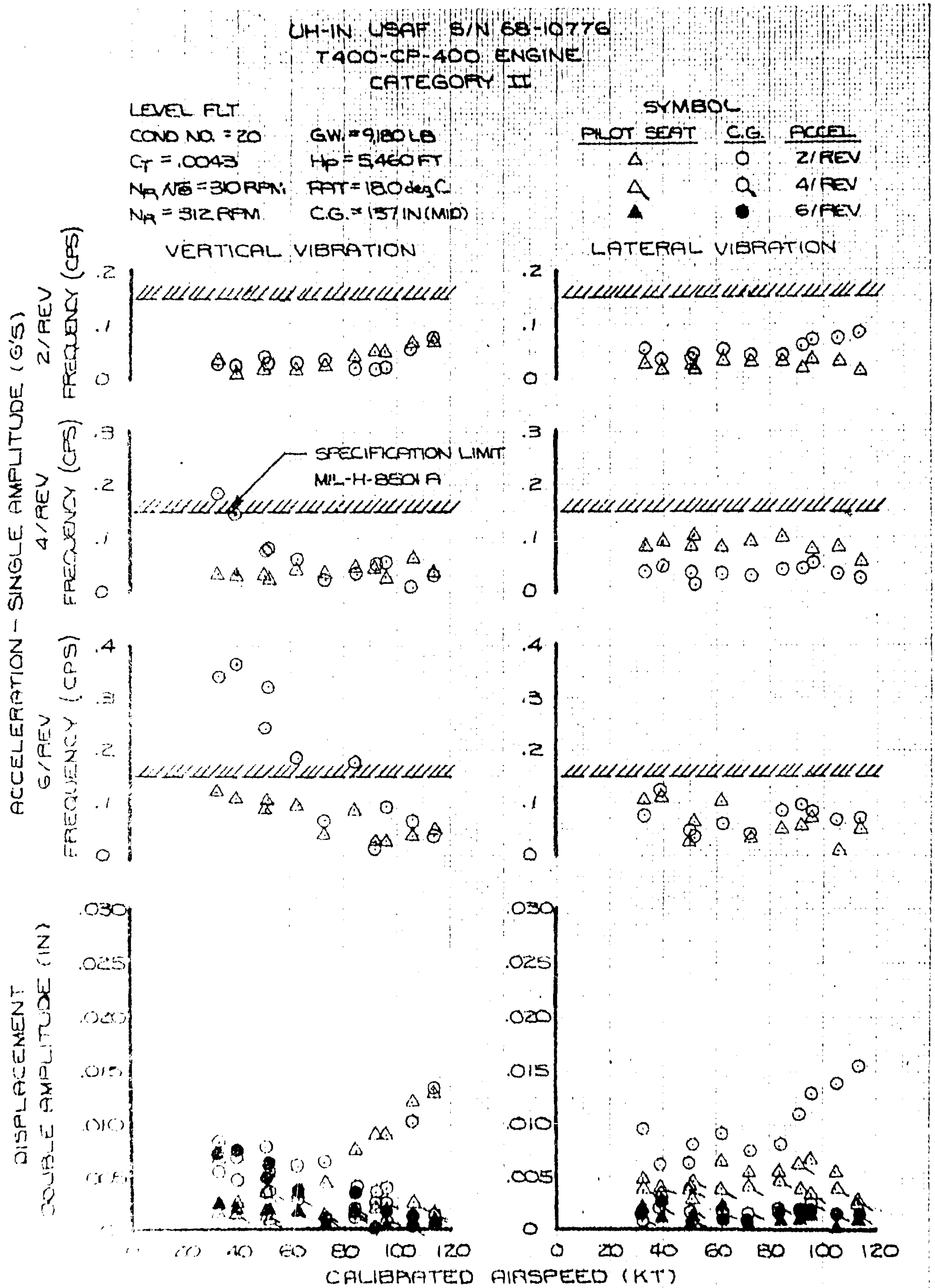


FIGURE 103 VIBRATION CHARACTERISTICS

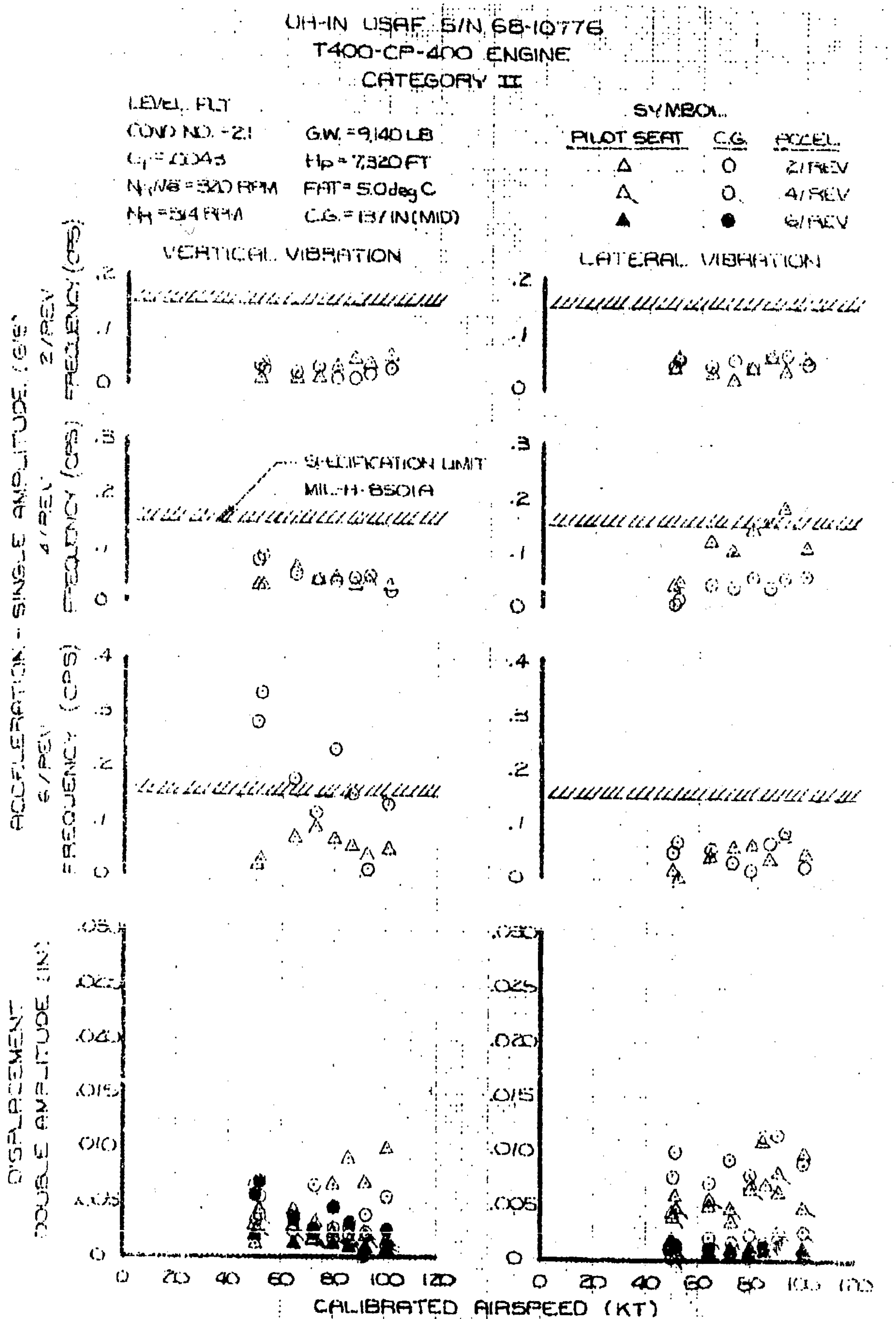


FIGURE 104 VIBRATION CHARACTERISTICS

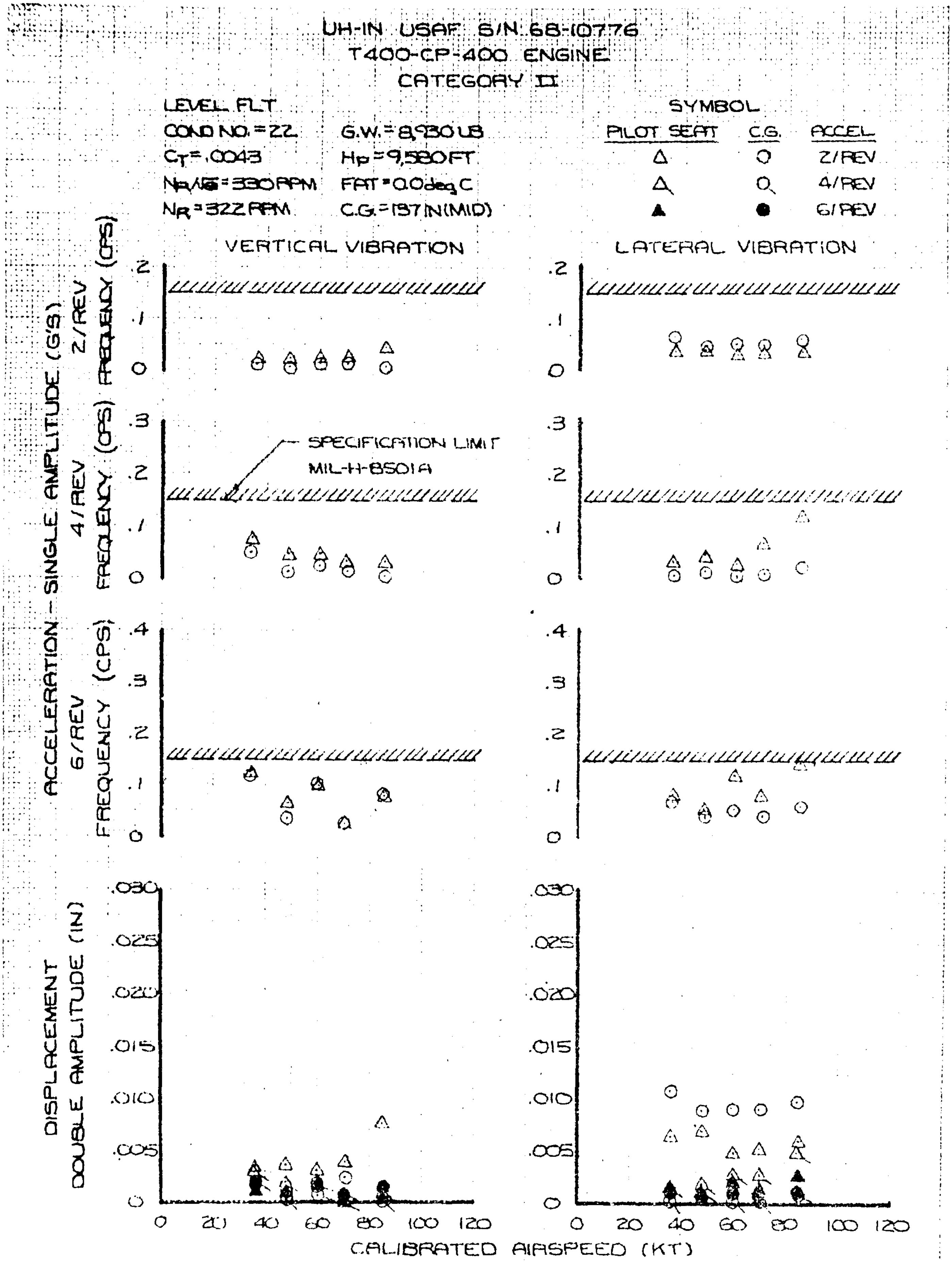


FIGURE 105 VIBRATION CHARACTERISTICS

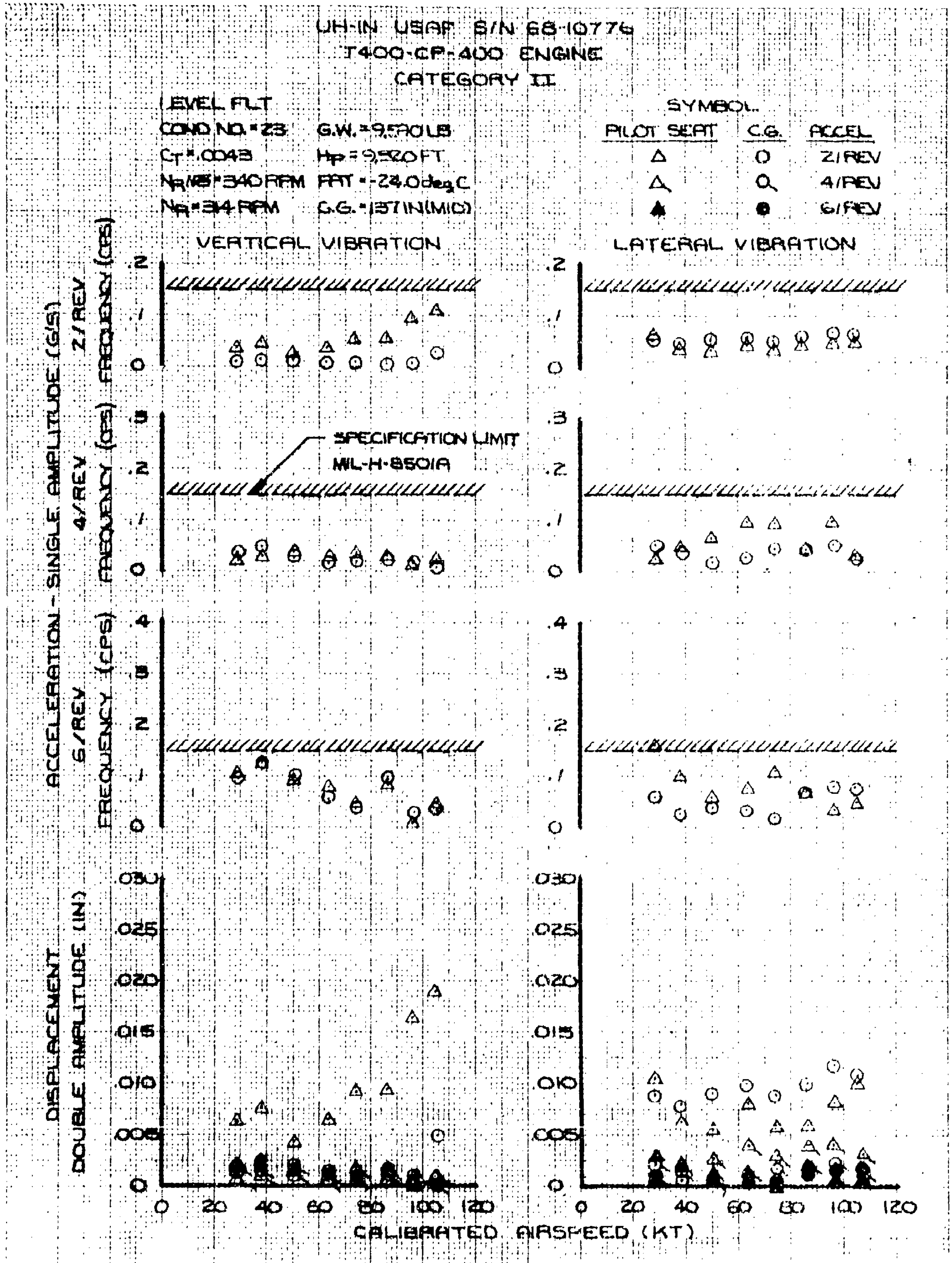


FIGURE 106 VIBRATION CHARACTERISTICS

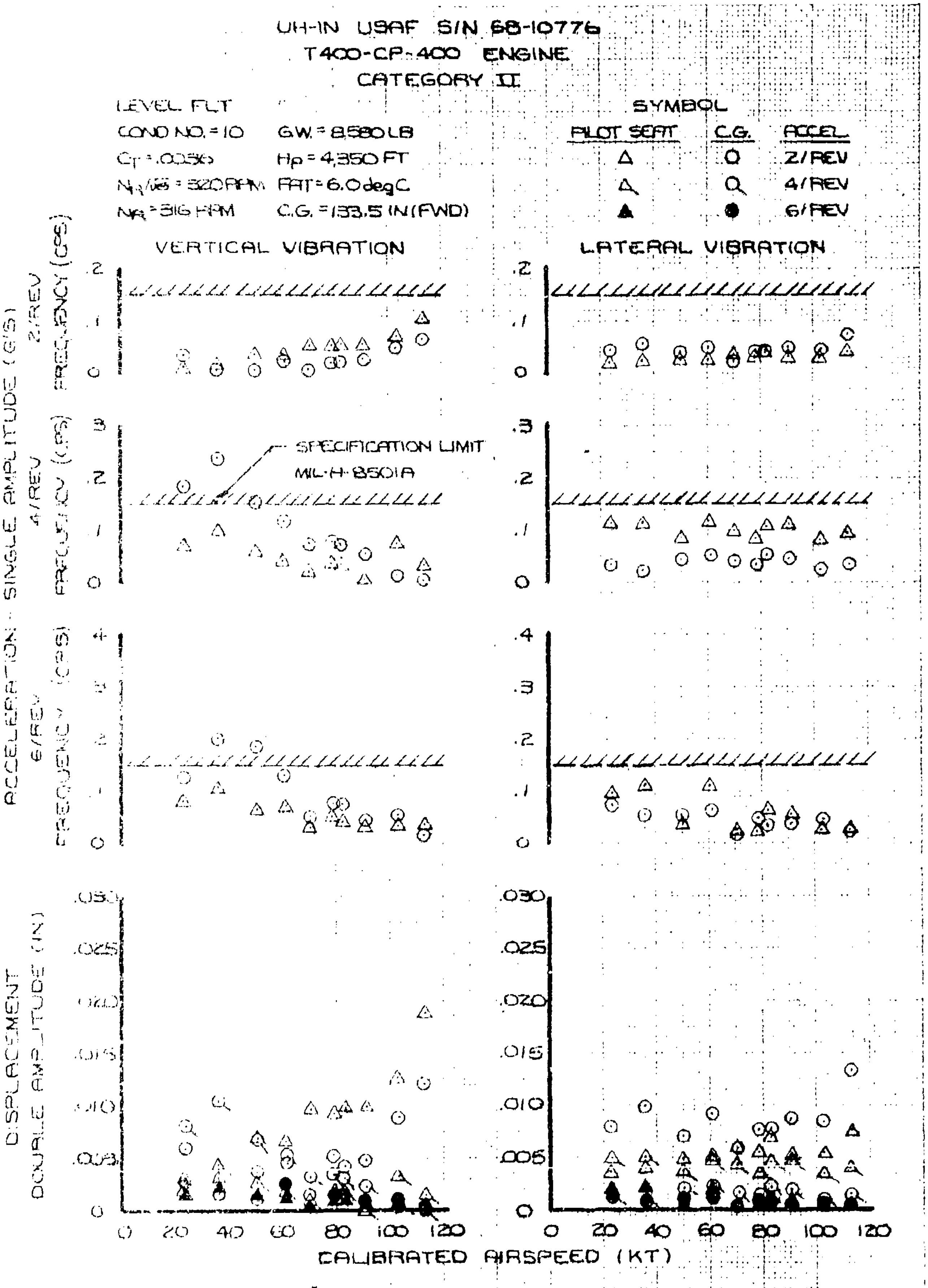


FIGURE 107 VIBRATION CHARACTERISTICS

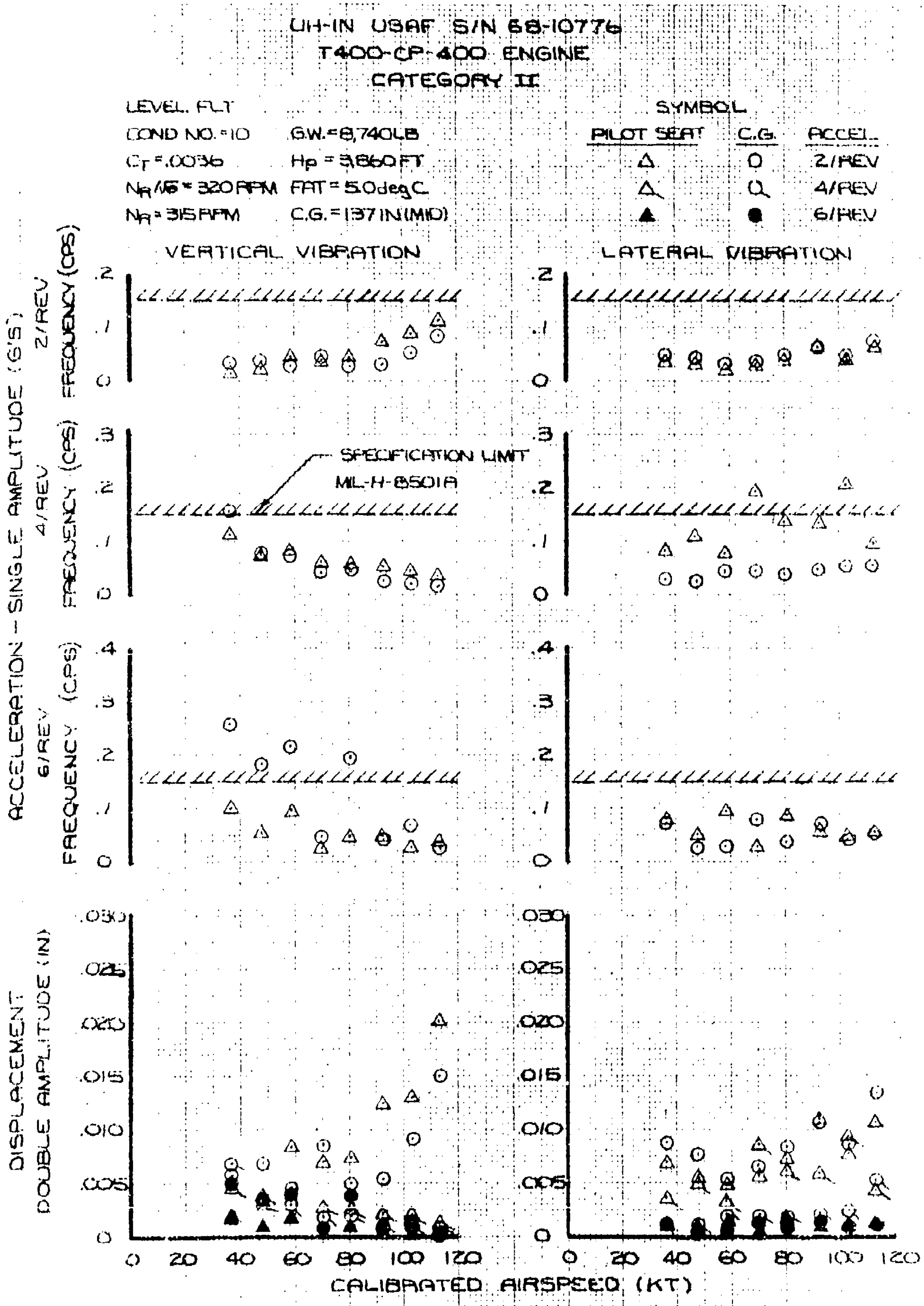


FIGURE 108 VIBRATION CHARACTERISTICS

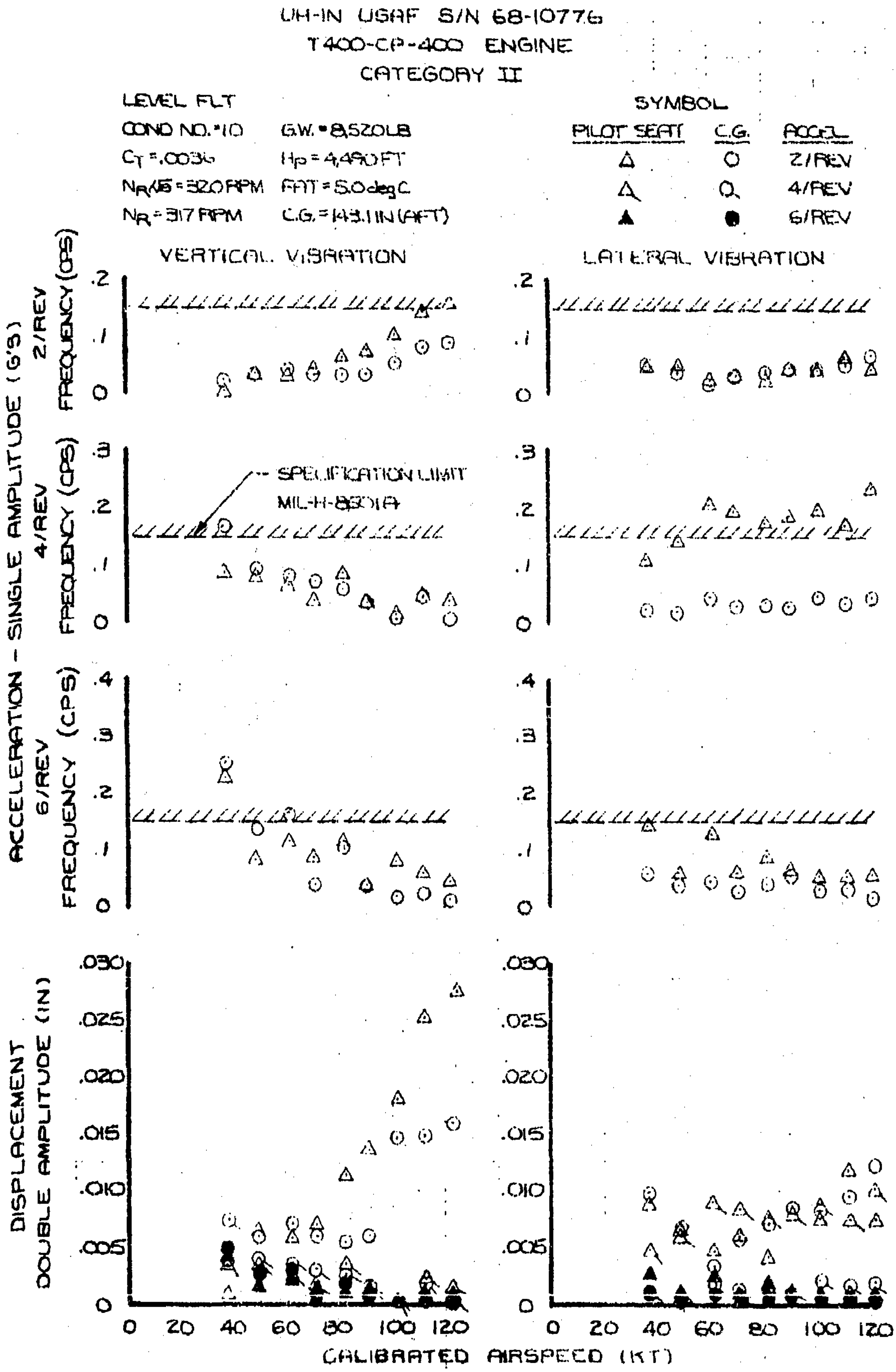


FIGURE 109 VIBRATION CHARACTERISTICS

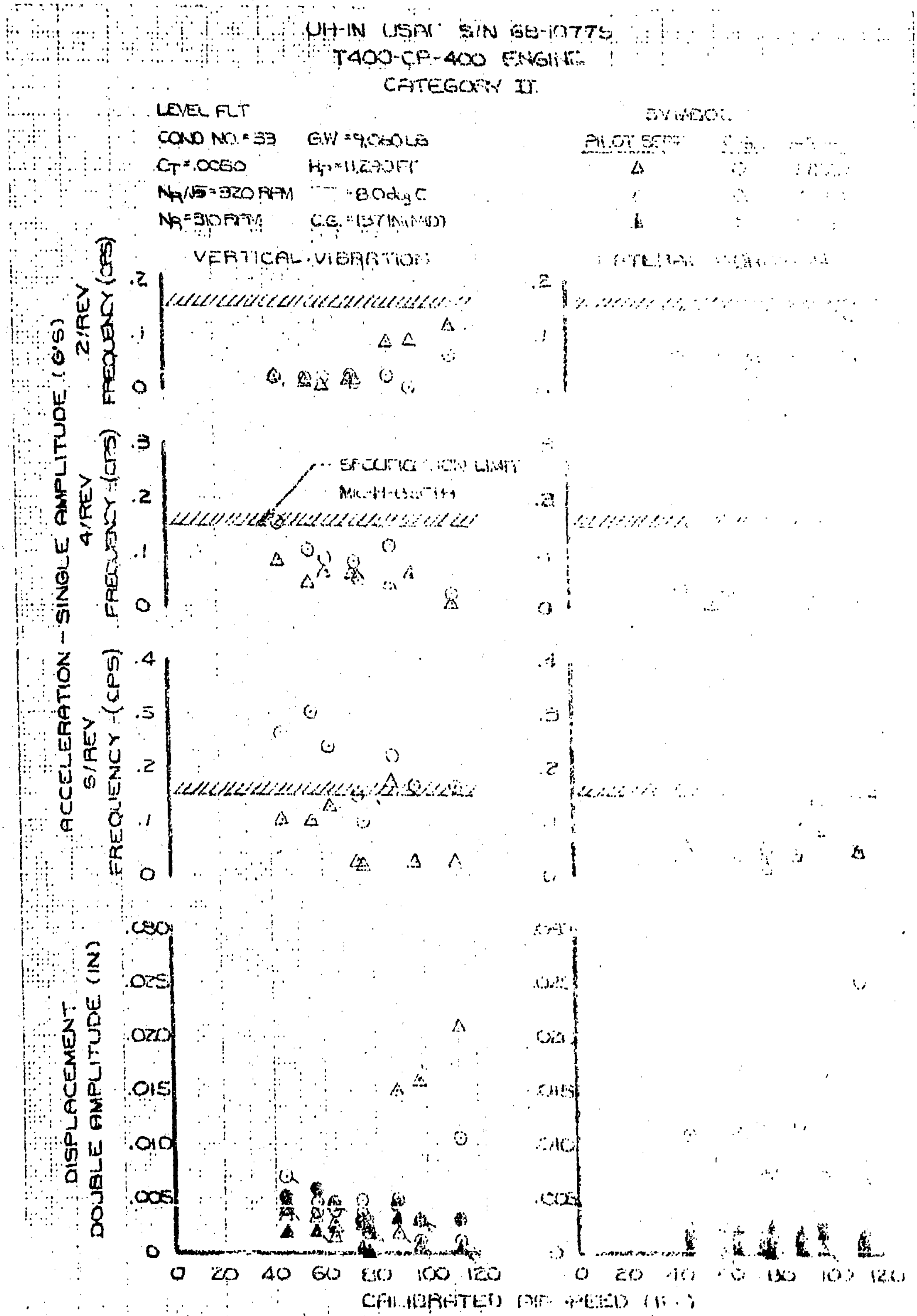


FIGURE 110 VIBRATION CHARACTERISTICS

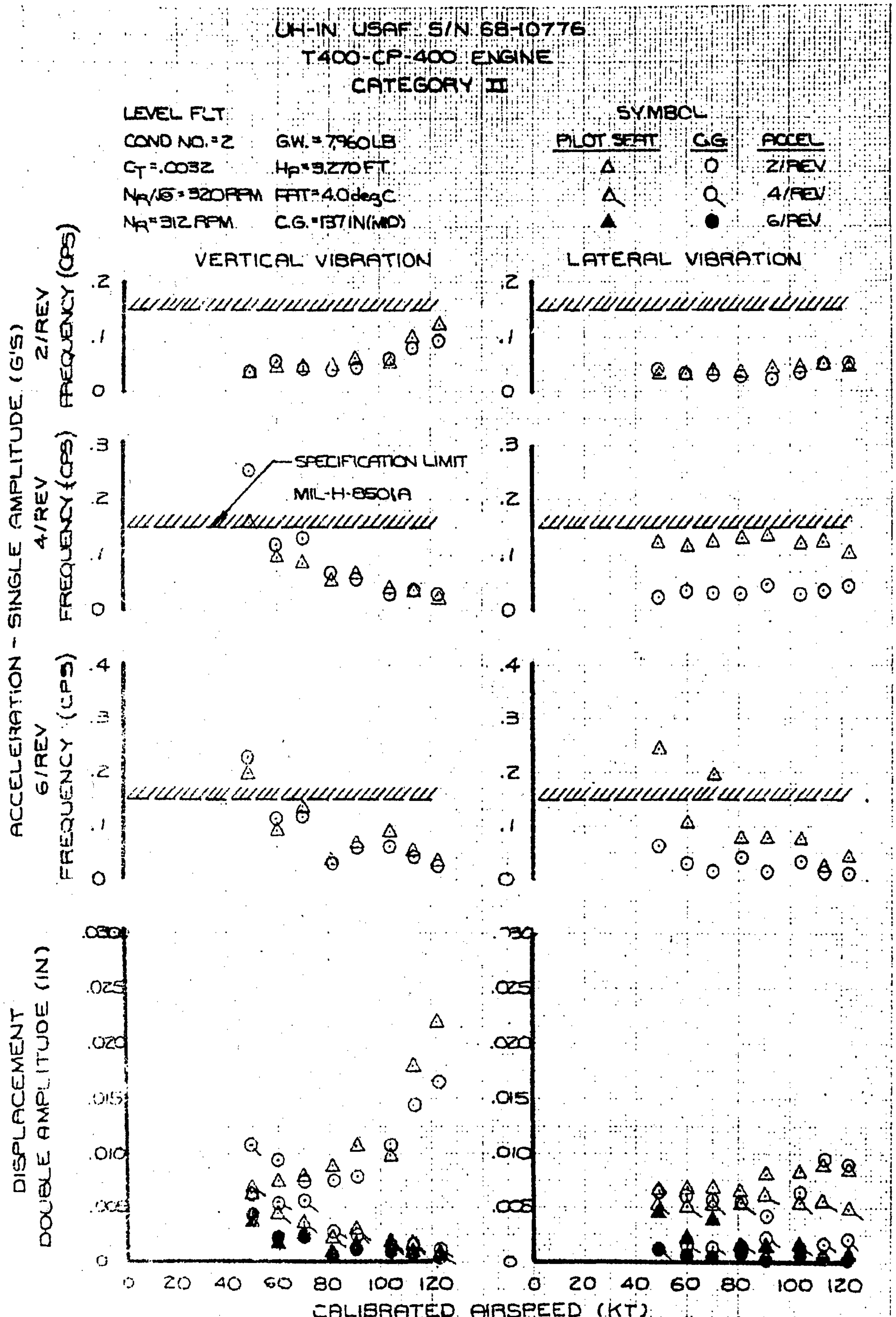


FIGURE 111 VIBRATION CHARACTERISTICS

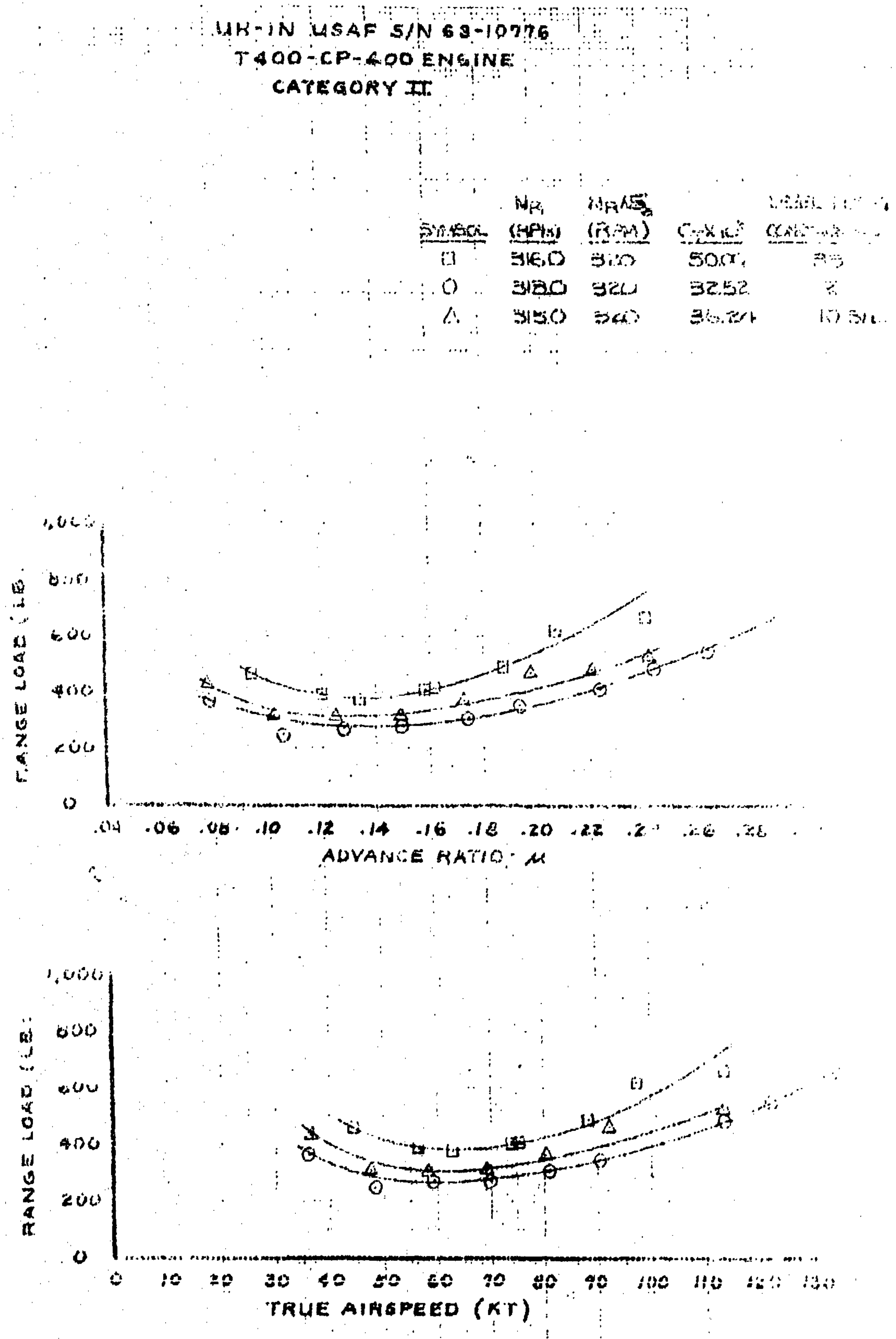
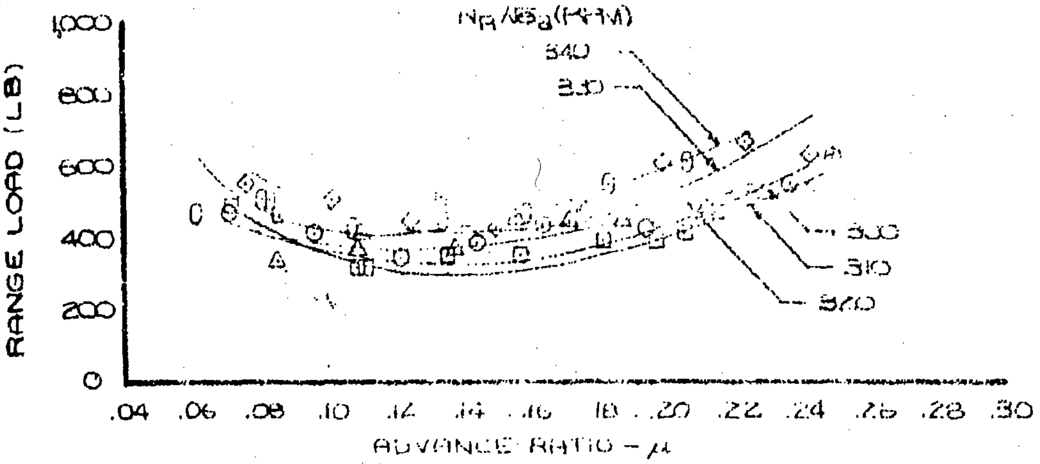


FIGURE 112 . PITCH LINK LOAD SURVEY

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SYMBOL	N_R (RPM)	$N_R/\sqrt{\theta_a}$ (RPM)	$C_T \times 10^4$	LEVEL FLIGHT CONDITION NO.
○	305.0	300	42.96	19
□	313.0	310	42.80	20
△	314.0	320	43.20	21 S/E
◇	322.0	330	42.51	22
0	314.0	340	43.36	23



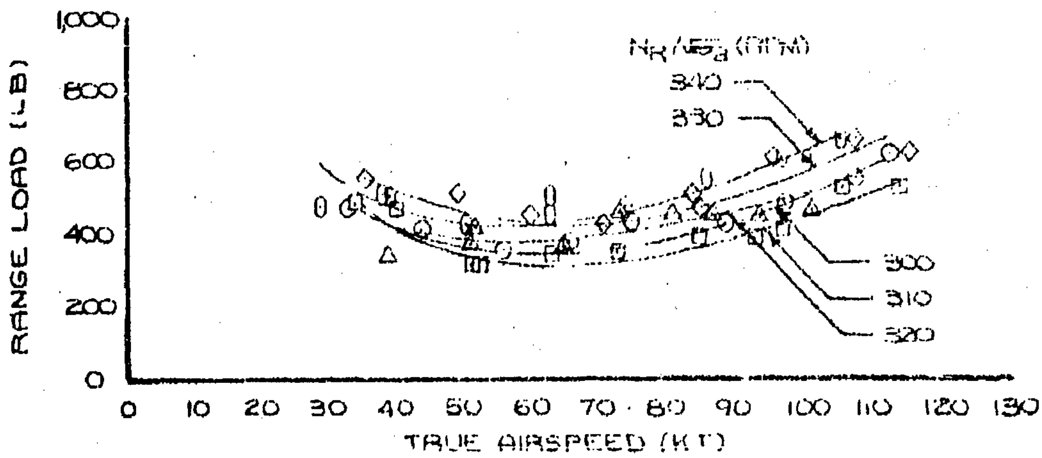


 FIGURE 113 PITCH LINK LOAD SURVEY

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SYM	GROSS WT (LB)	PRESS ALT (FT)	OAT (deg C)	ROTOR SPEED (RPM)
O	8,620	5,000	9.0	294 (91%)
Δ	8,430	5,000	9.0	324 (100%)
□	8,600	5,000	14.0	[illegible] (103.6%)

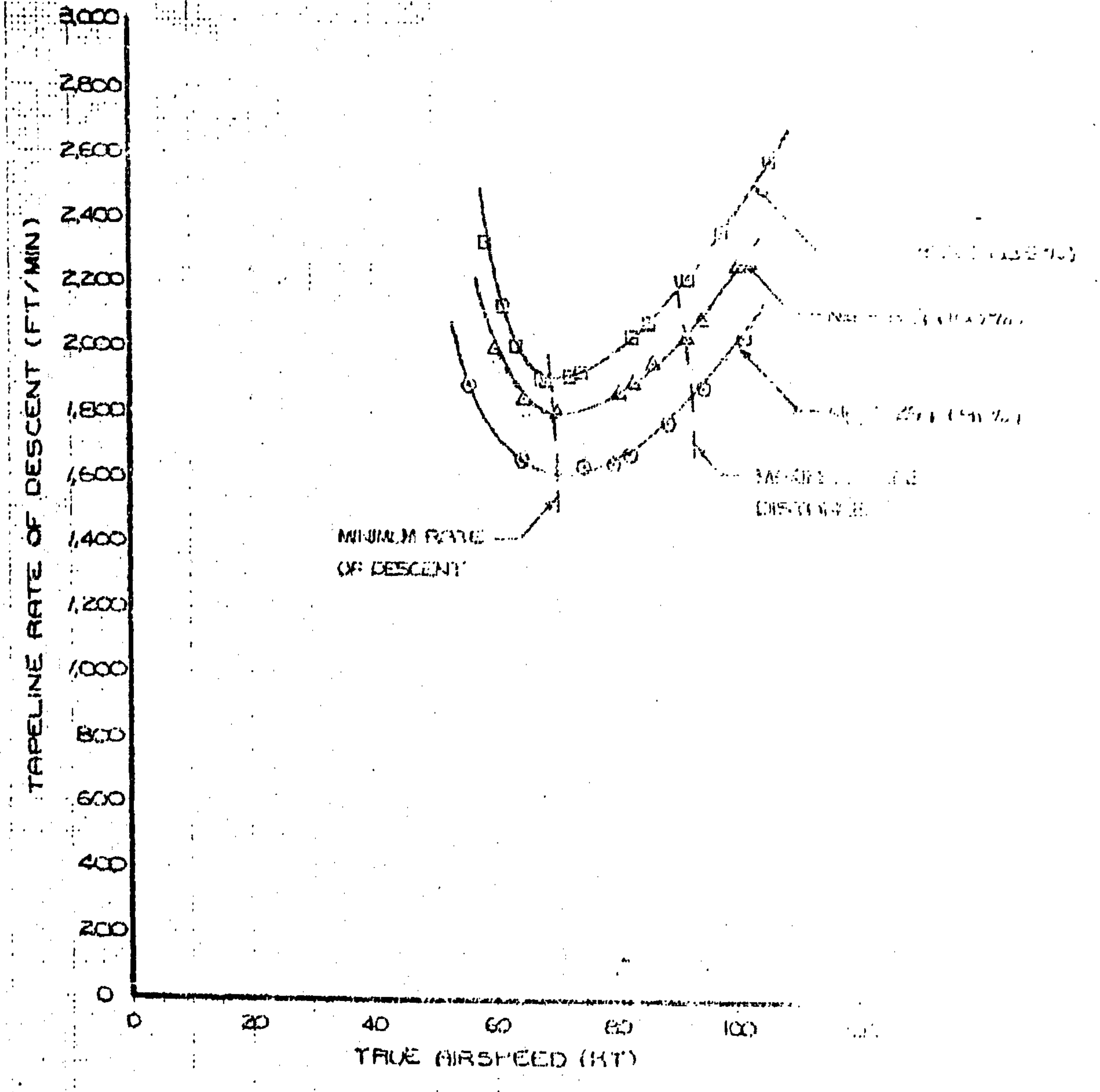


FIGURE 114 SAWTOOTH AUTOROTATIONAL DESCENT PERFORMANCE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SYM	GROSS WT (LB)	PRESS ALT (FT)	FAT (deg C)	ROTOR SPEED (RPM)
○	8,640	10,000	-3.0	294 (91%)
△	8,610	10,000	-3.0	324 (100%)
□	8,400	10,000	-3.0	335 (103.5%)

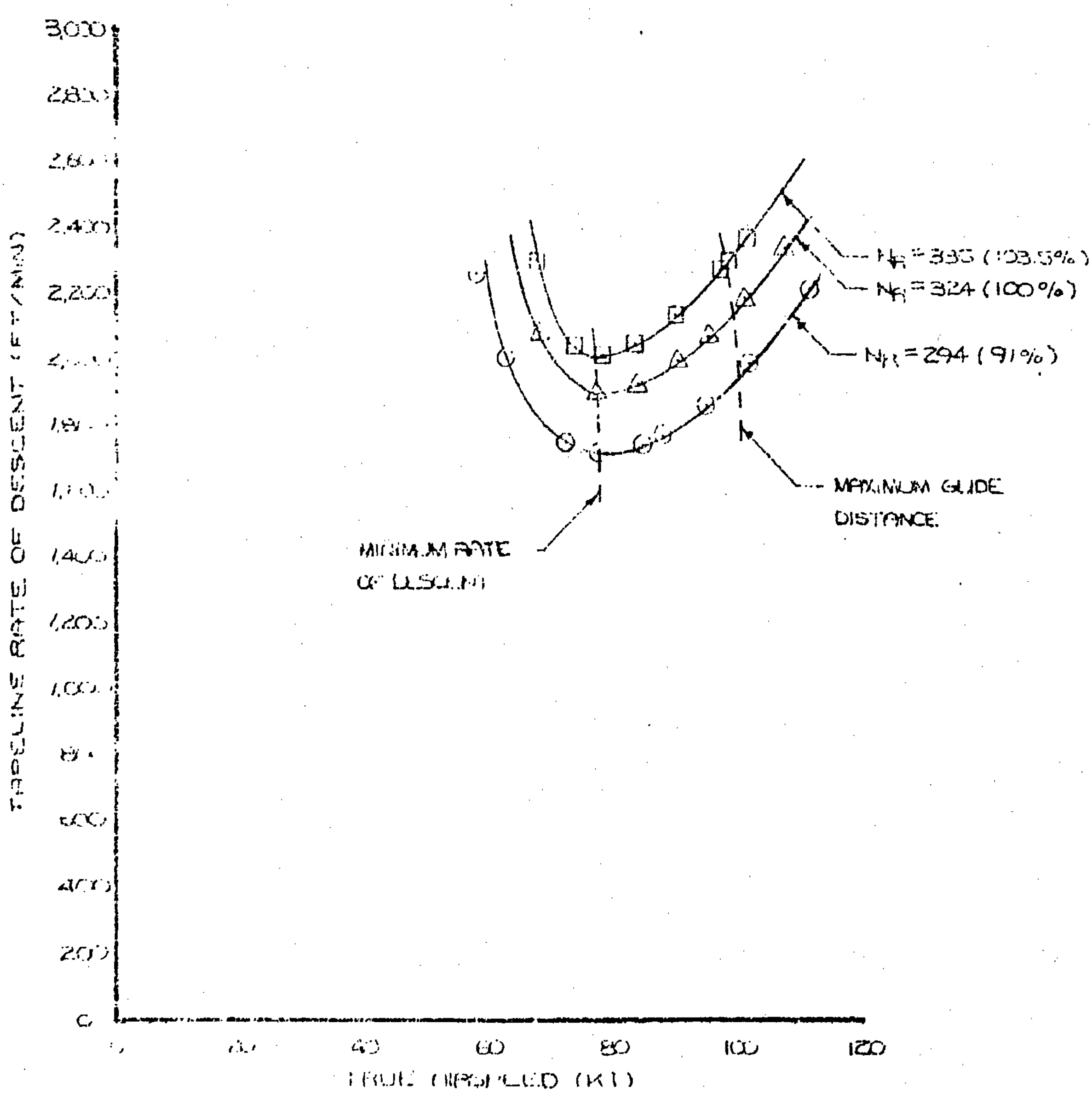


 FIGURE 115 SAWTOOTH AUTOROTATIONAL DESCENT PERFORMANCE

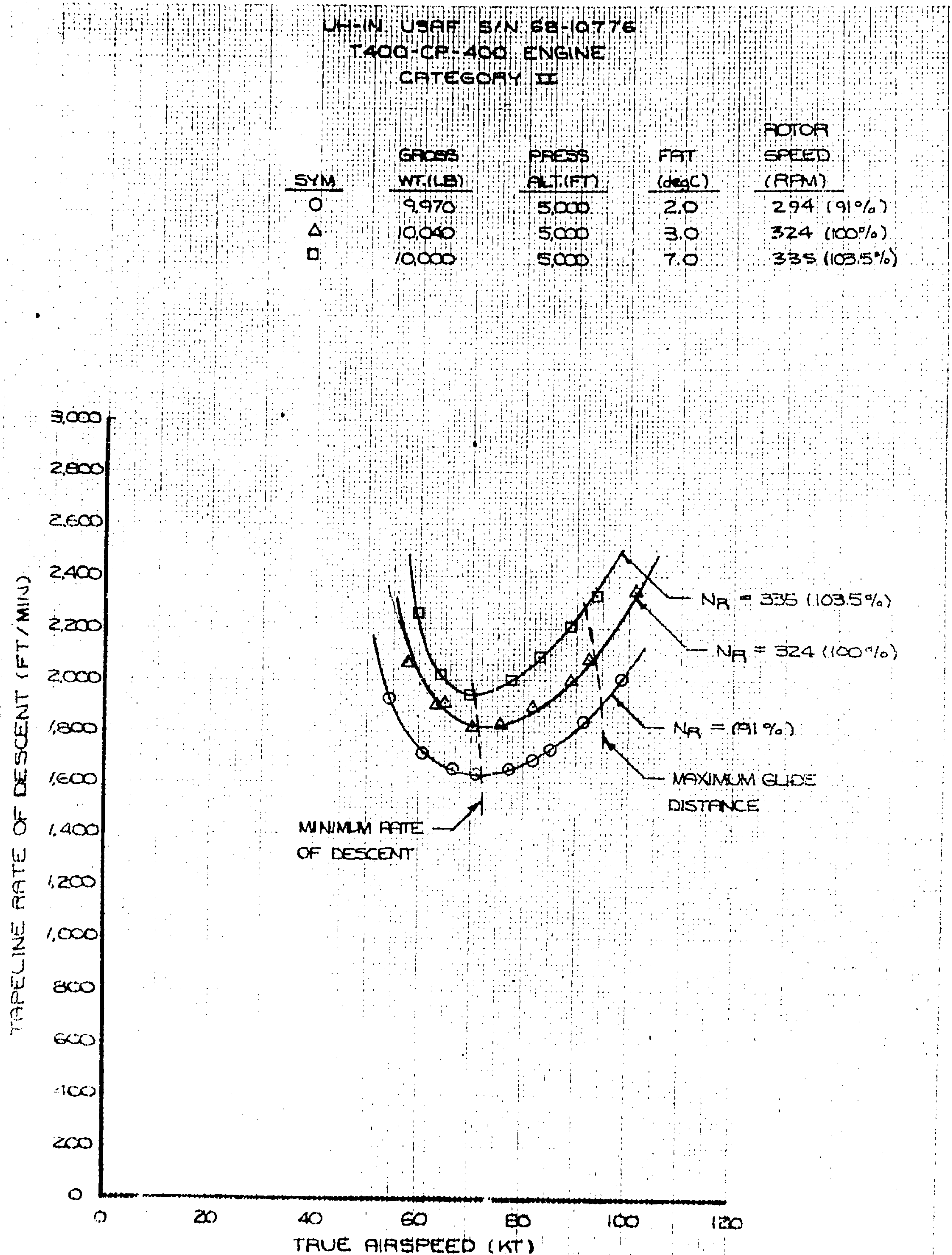


FIGURE 116 SAWTOOTH AUTOROTATIONAL DESCENT PERFORMANCE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SYM	GROSS WT (LB)	PRESS. ALT (FT)	FAT (deg C)	ROTOR SPEED (RPM)	
○	10,210	10,000	-12.0	294	(91%)
△	9,840	10,000	-11.0	314	(97%)
□	9,930	10,000	-10.0	324	(100%)

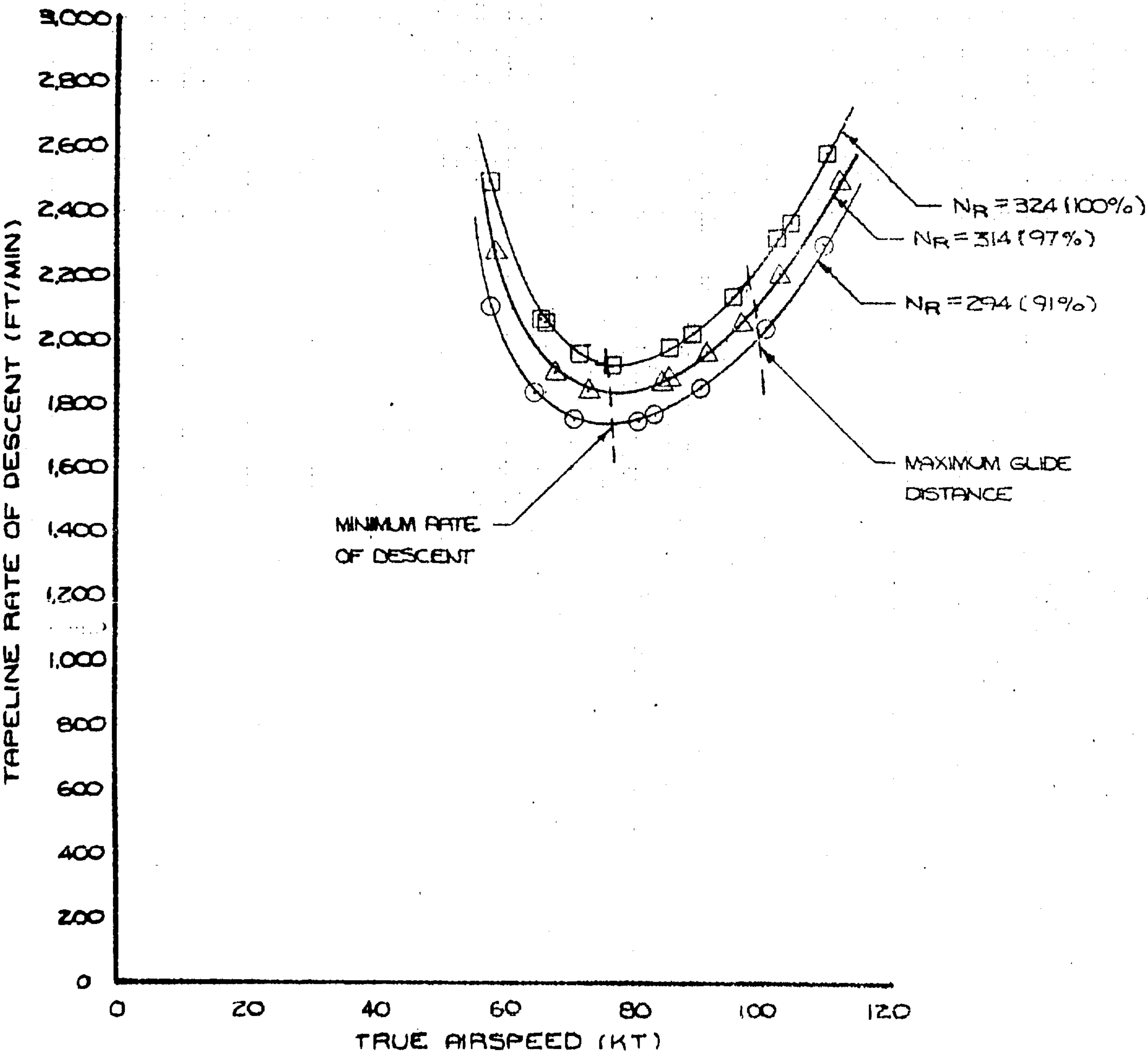


 FIGURE 117 SAWTOOTH AUTOROTATIONAL DESCENT PERFORMANCE

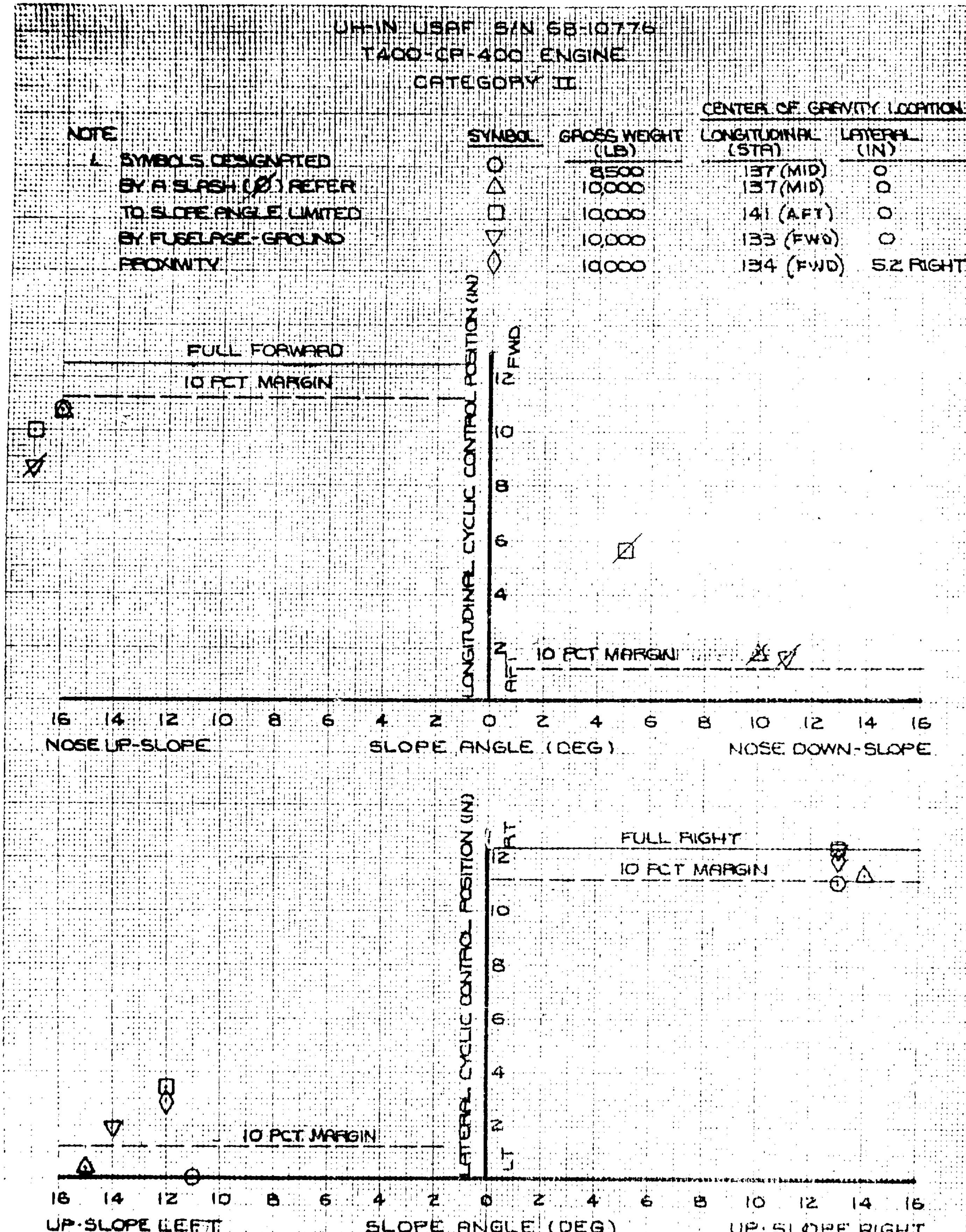


FIGURE 118 SLOPE LANDING SLOPE ANGLE LIMITS AND CYCLIC CONTROL POSITIONS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SYM	GROSS WT. (LB)	PRESS. ALT. (FT)	FAT (deg C)	SHP_A / SHP_R
○	8,520	3,870	15.0	0.7964
□	8,520	4,210	13.0	0.7720

NOTES :

1. WINDS LESS THAN 3 KNOTS.
2. SHP_A IS SHP AVAILABLE – TEST DAY
3. SHP_R IS SHP REQUIRED TO HOVER OGE – TEST DAY
4. FOLLOWING CUT OF ONE ENGINE, THE COLLECTIVE HELD FIXED FOR 2 SECONDS – THEN CORRECTIVE ACTION TAKEN
5. ROTOR SPEED AT ENGINE CUT 324 RPM (100%)
6. C.G. LOCATION ~ 137 IN (MID)
7. SYMBOL LEGEND :
   - ● LANDING MADE
   - ○ GO-AROUND MADE
   - ◐ LANDING MADE BUT COULD POSSIBLY GO-AROUND
   - ⦶ GO-AROUND MADE – BUT MARGINAL

   TOUCHDOWN SPEED NOTED FOR EACH LANDING POINT

   MINIMUM SINGLE SPEEDS
   LEVEL FLIGHT = 25 KCAS
   CLIMB = 25 KCAS

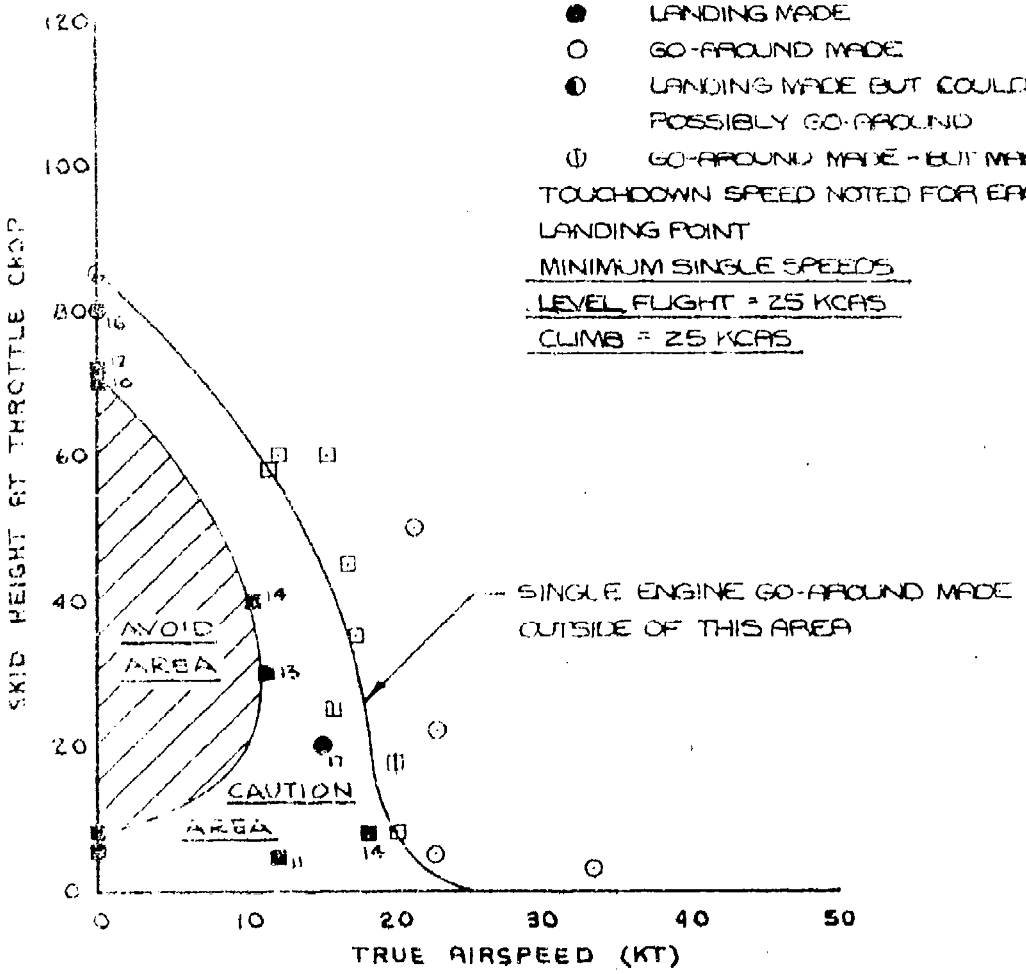


FIGURE 119 HEIGHT-VELOCITY PERFORMANCE

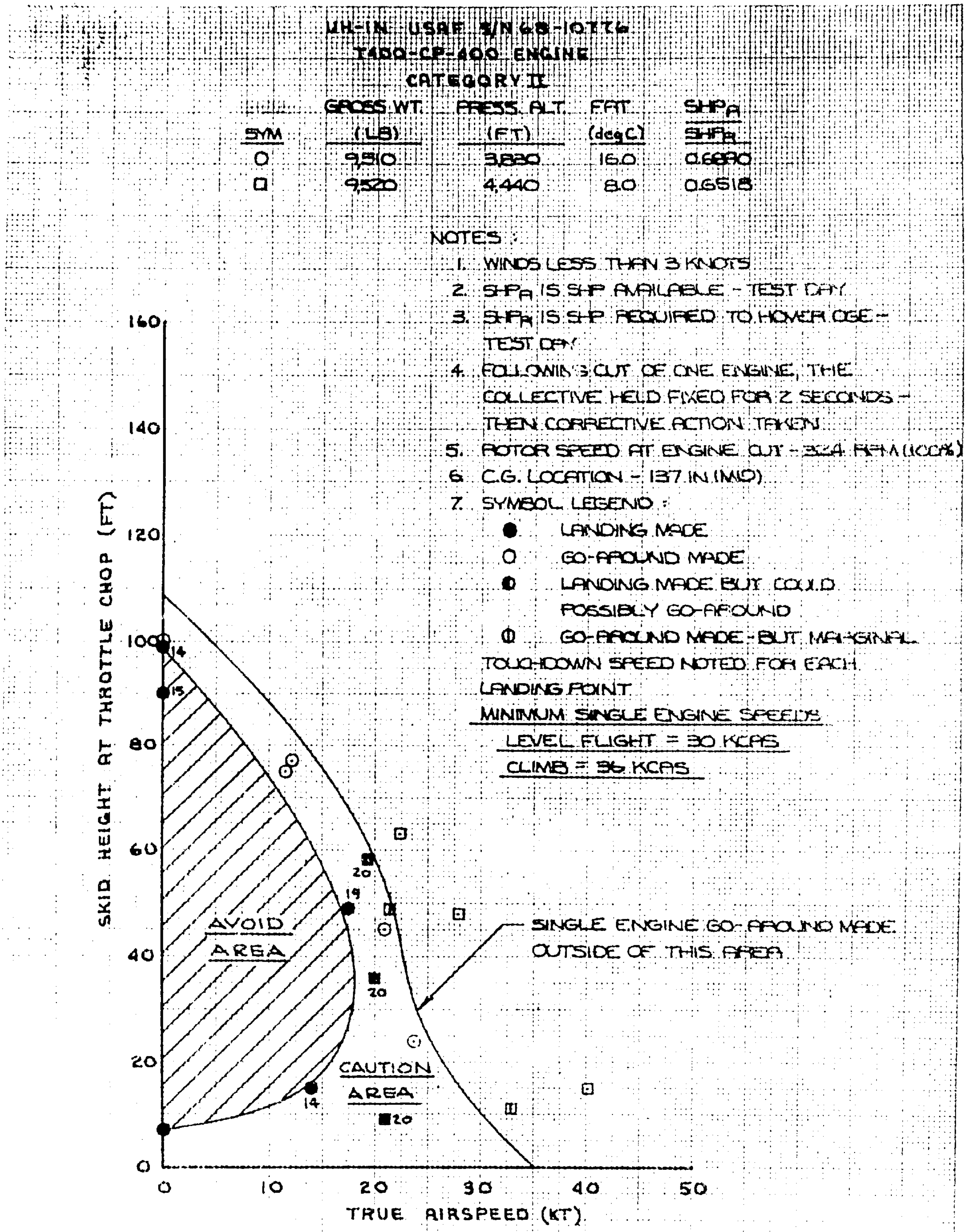


FIGURE 120 HEIGHT-VELOCITY PERFORMANCE

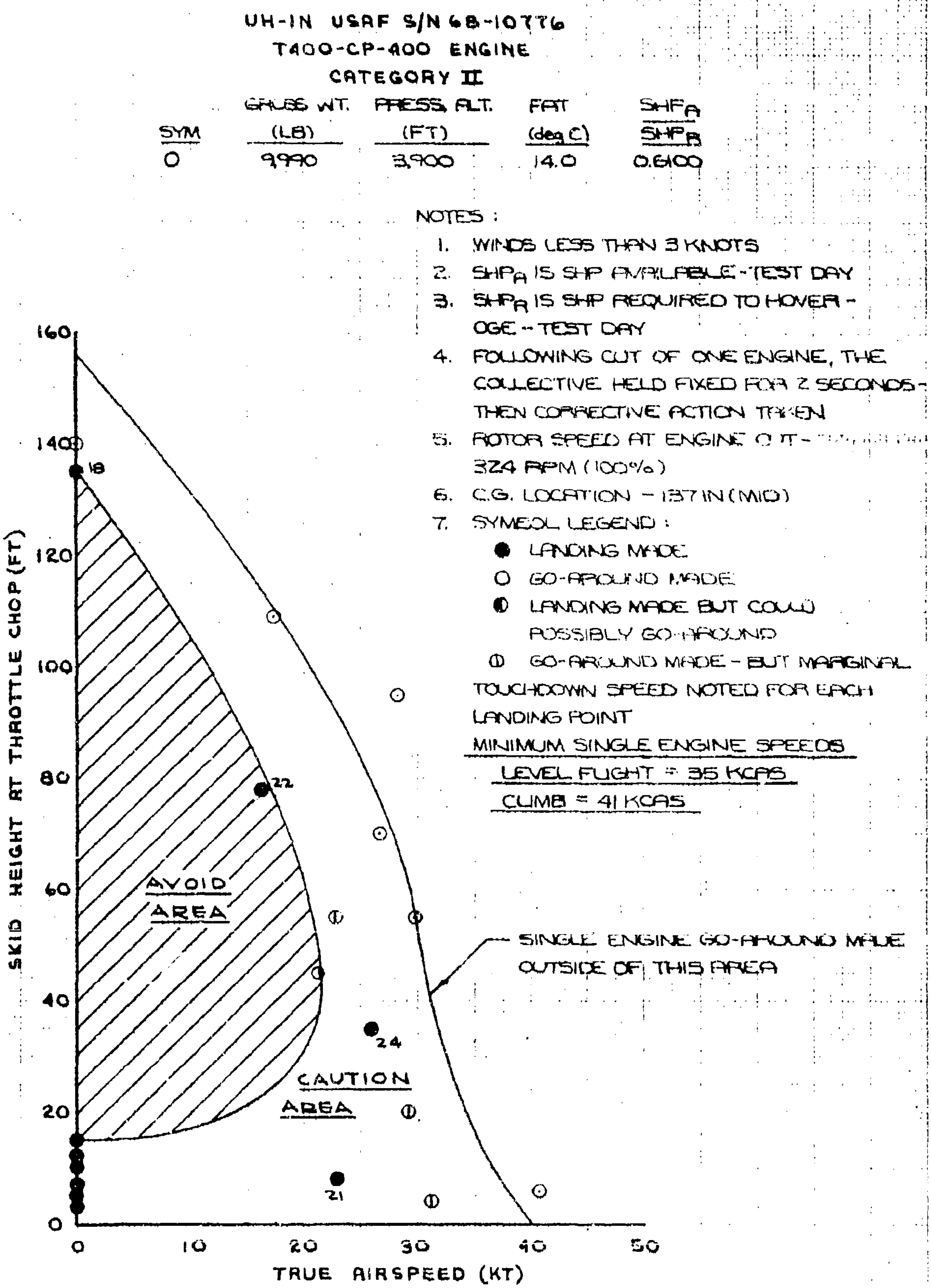


FIGURE 121 HEIGHT-VELOCITY PERFORMANCE

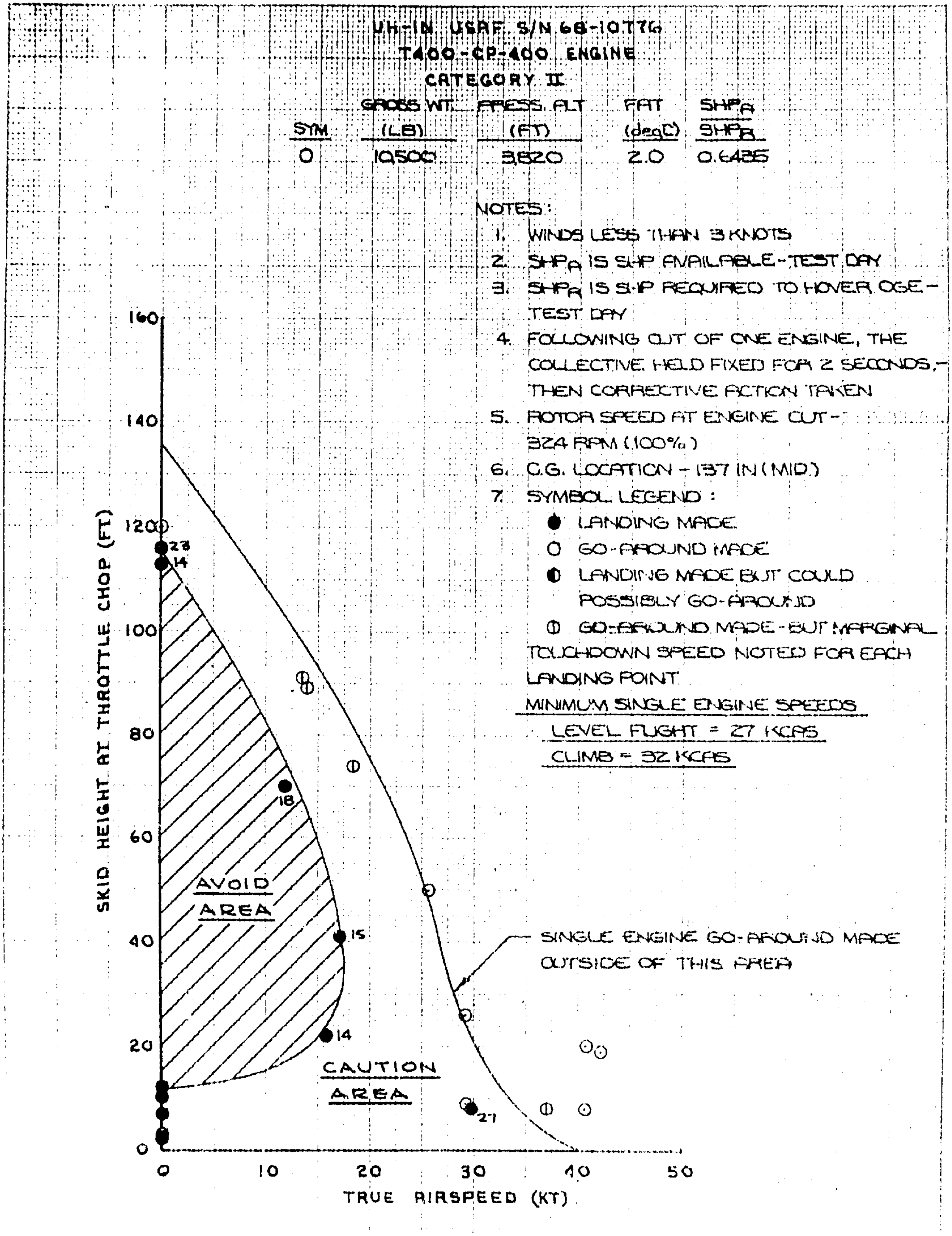


FIGURE 122 HEIGHT-VELOCITY PERFORMANCE

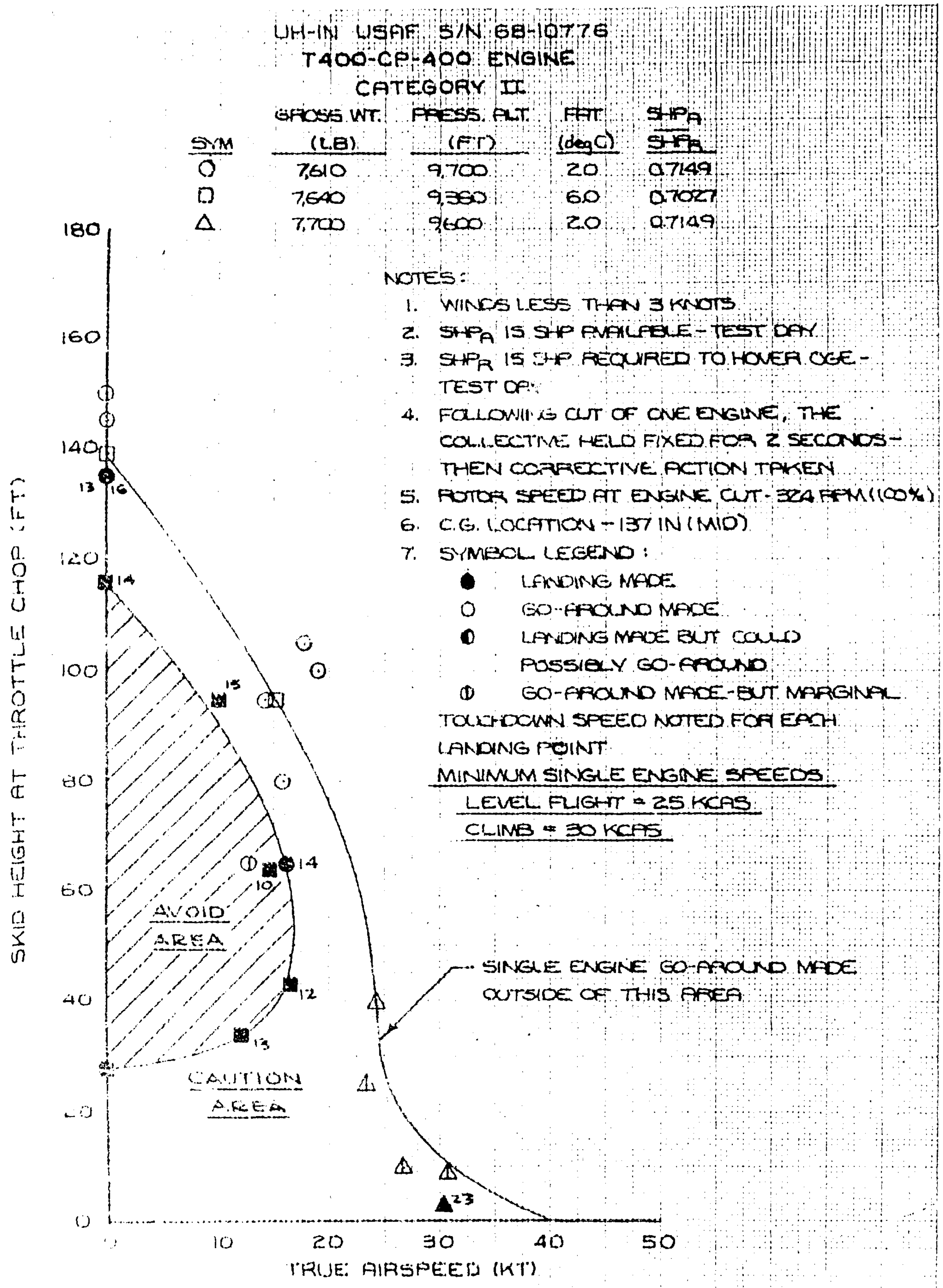


FIGURE 123 HEIGHT VELOCITY PERFORMANCE

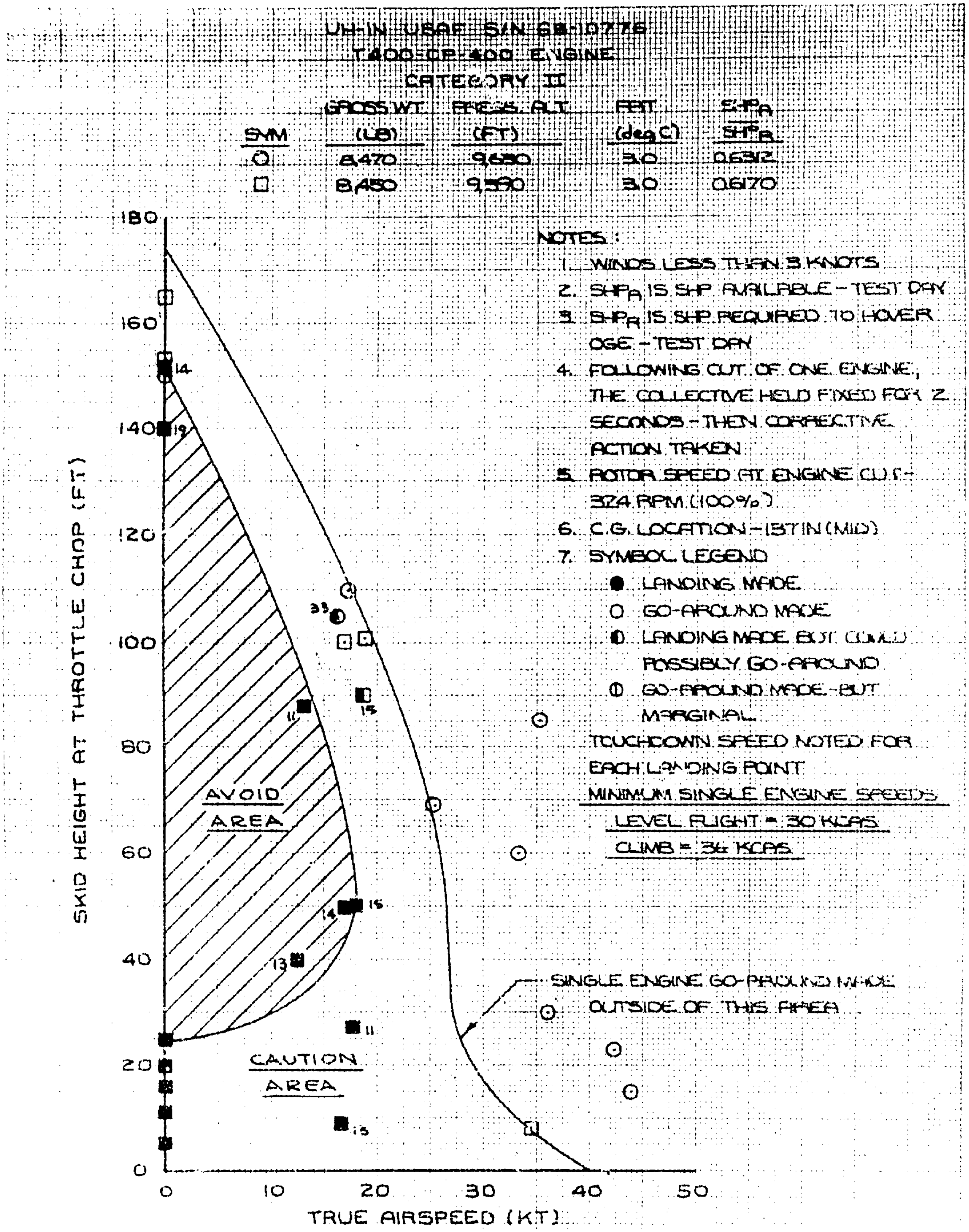


FIGURE 124 HEIGHT VELOCITY PERFORMANCE

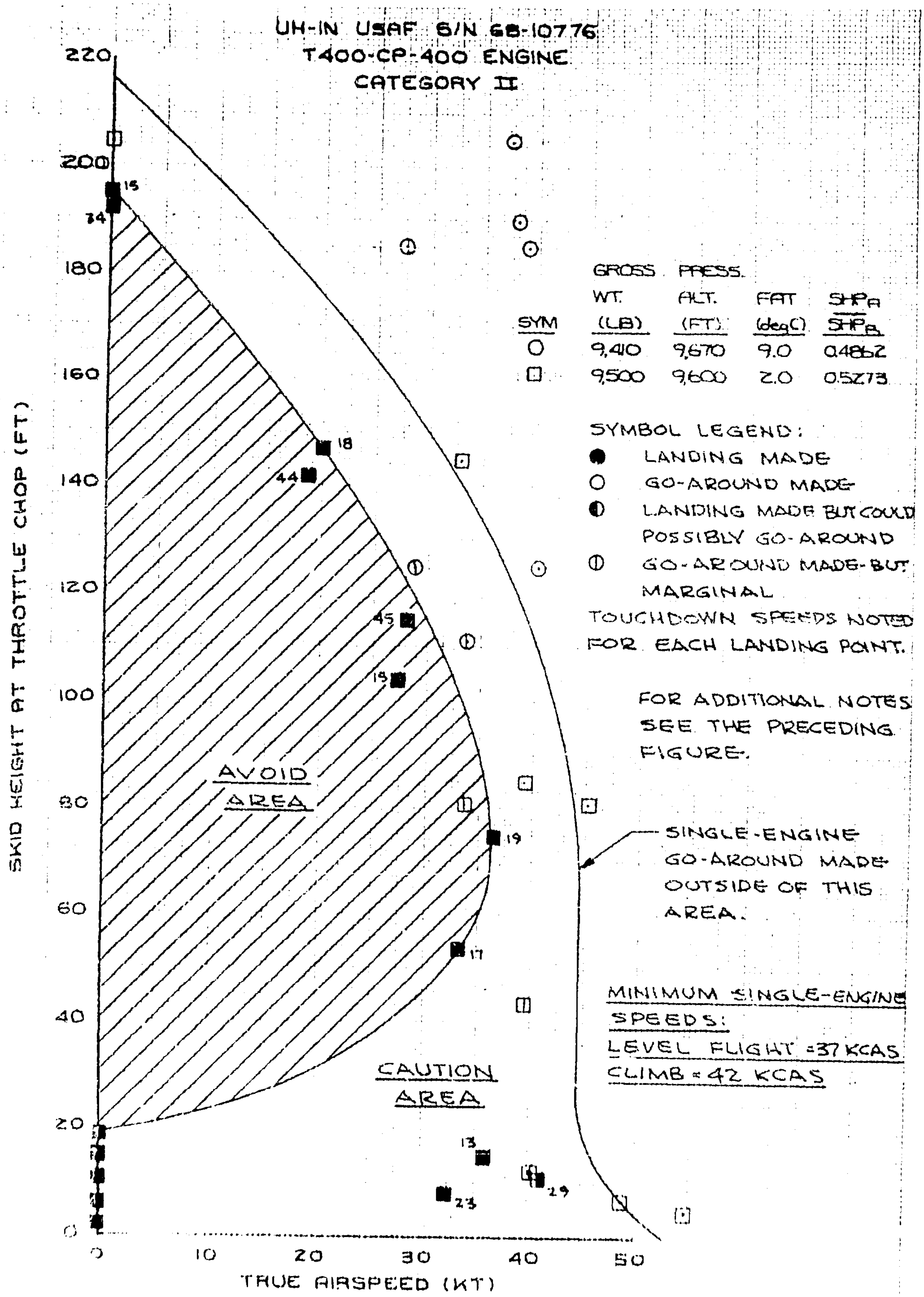


FIGURE [illegible] HEIGHT VELOCITY PERFORMANCE

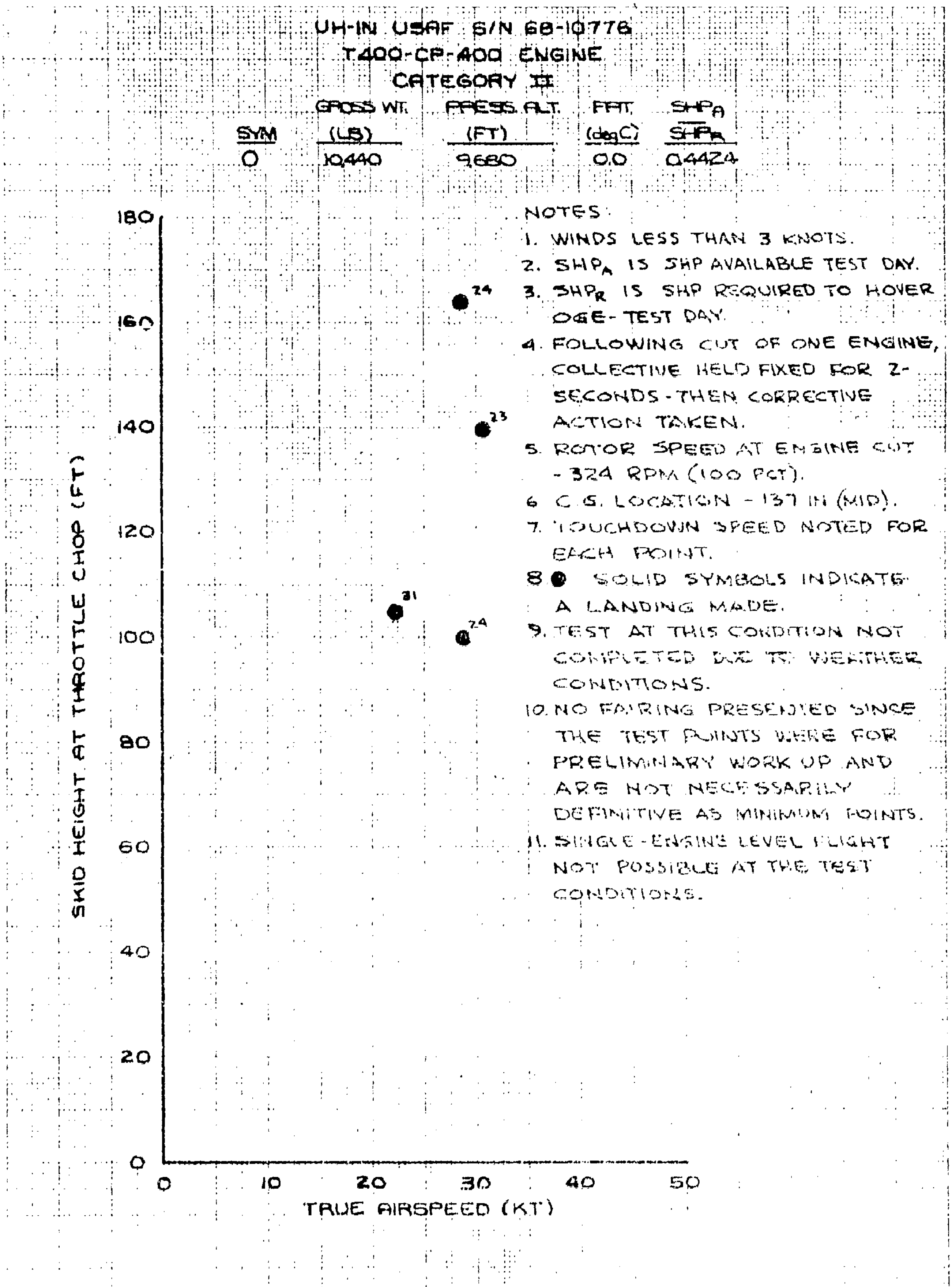


FIGURE 126. HEIGHT VELOCITY PERFORMANCE

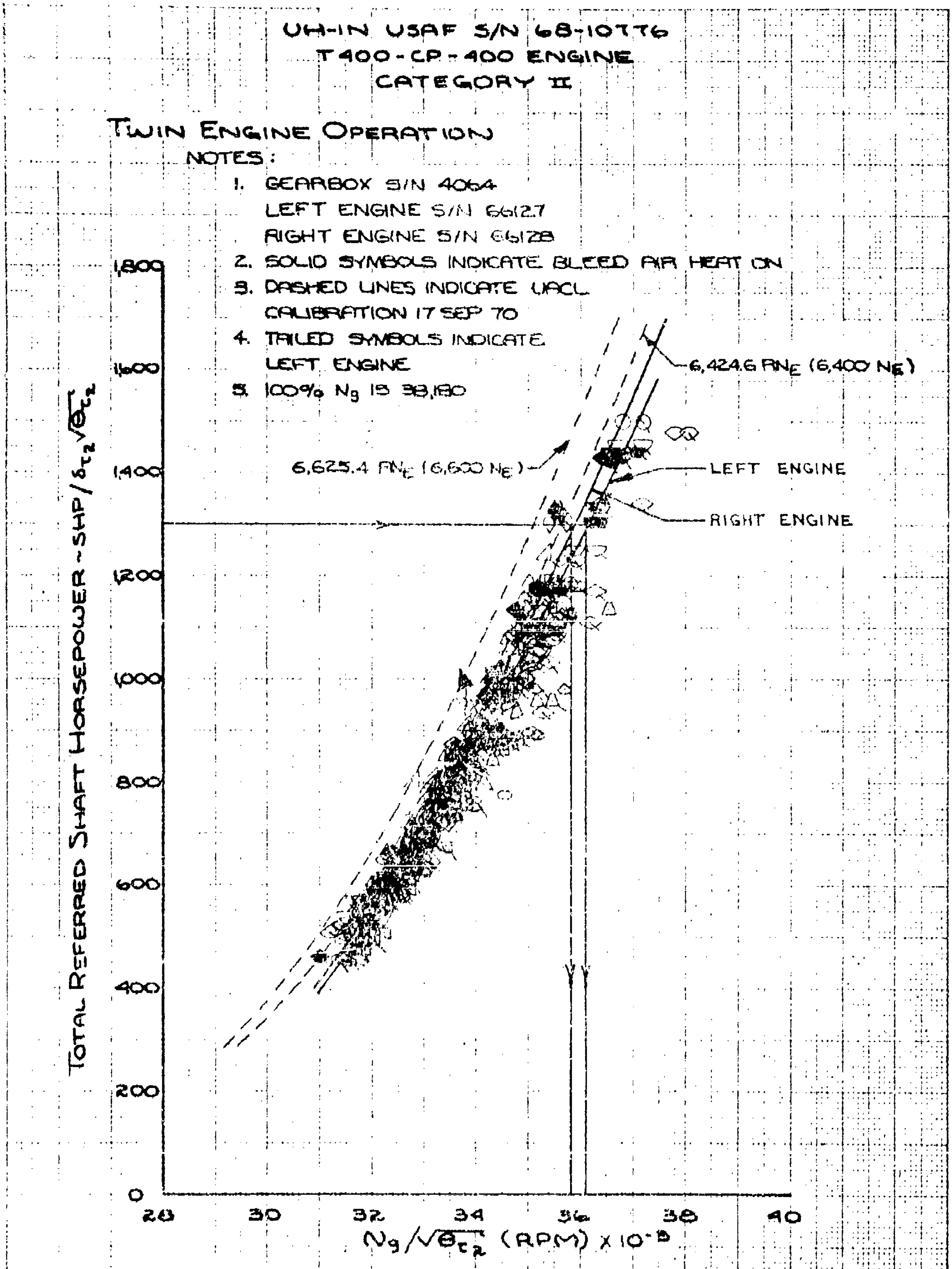


FIGURE 127 ENGINE CHARACTERISTICS

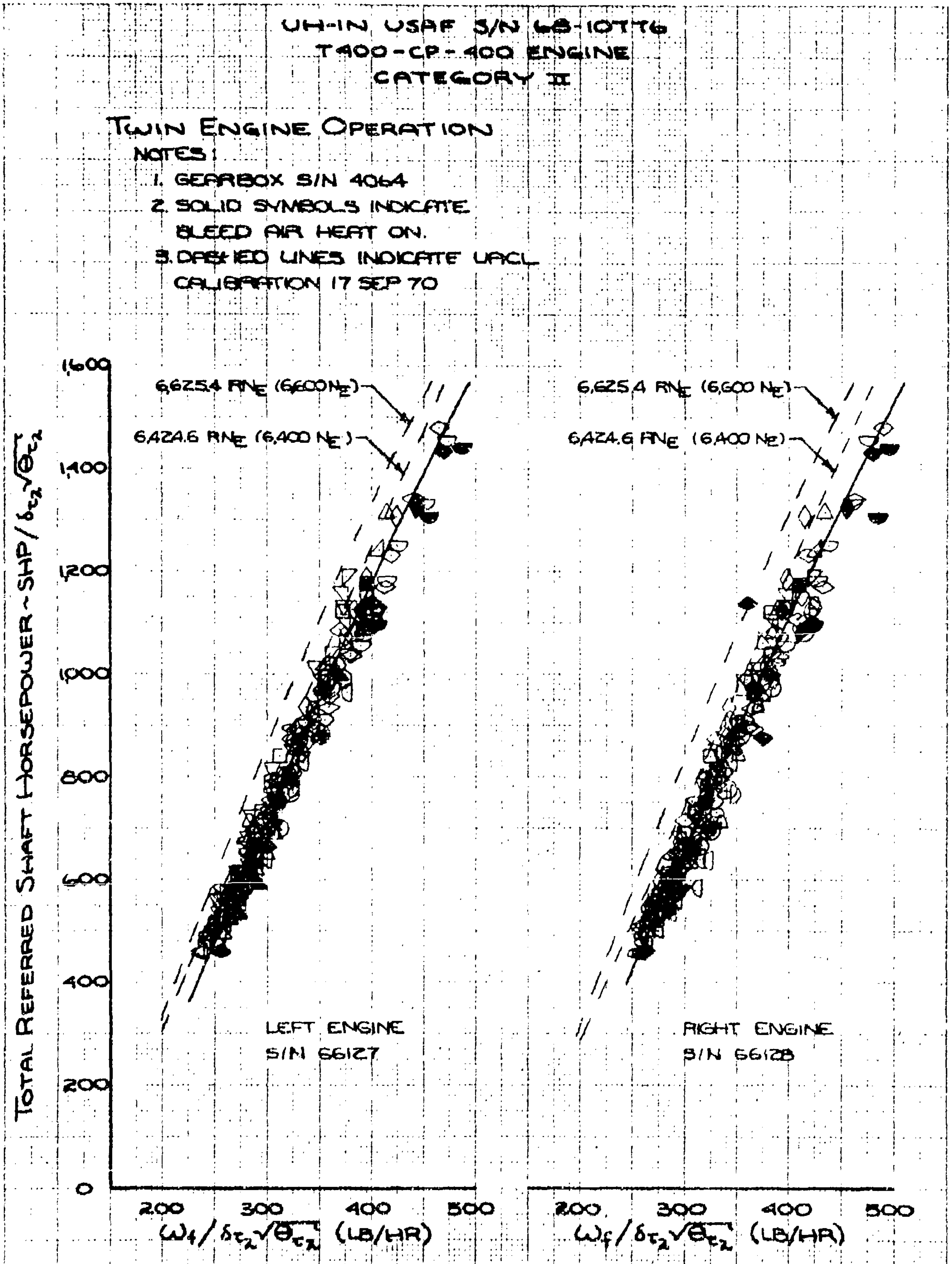


FIGURE 128 ENGINE CHARACTERISTICS

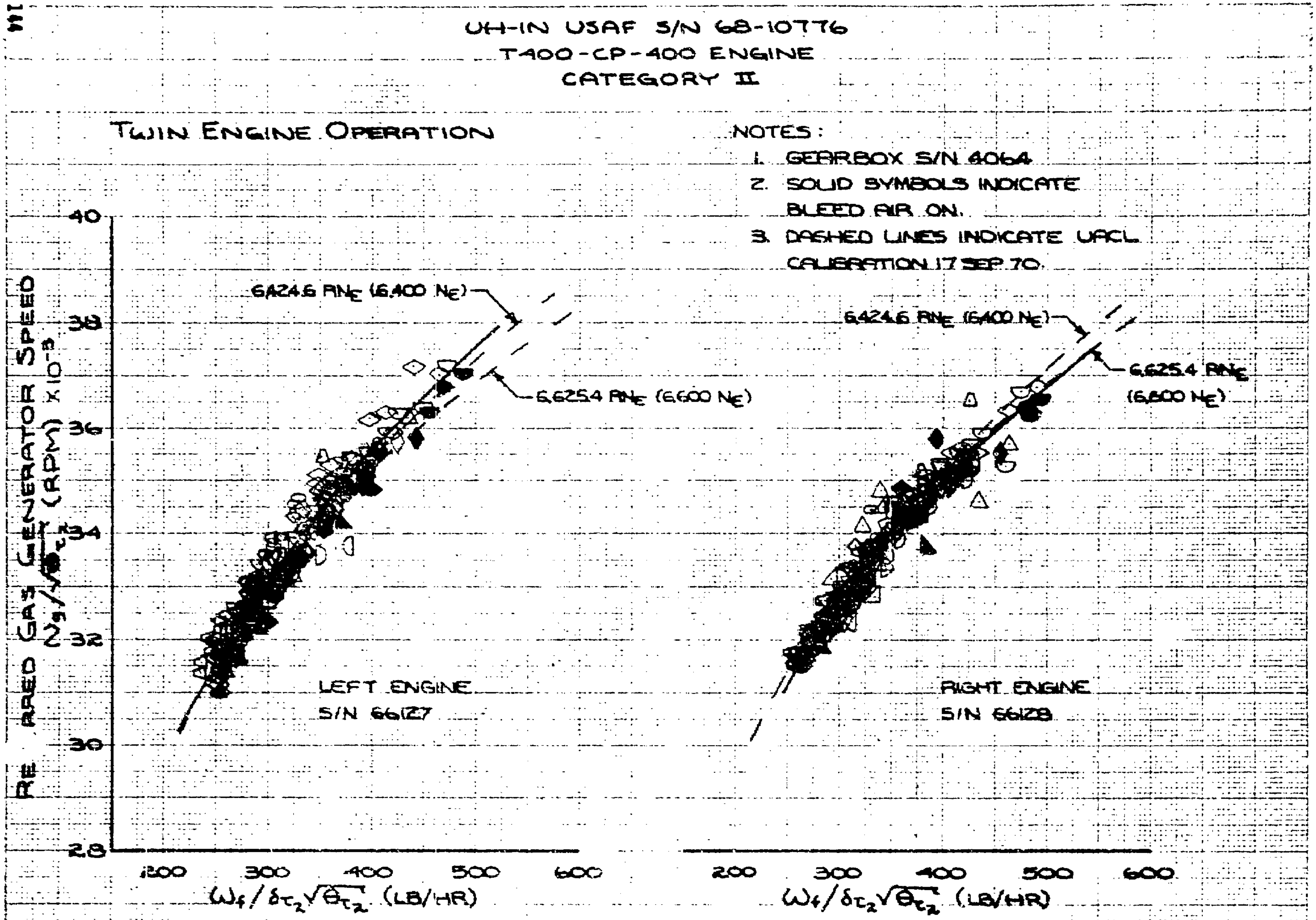


Figure 129 Engine Characteristics

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

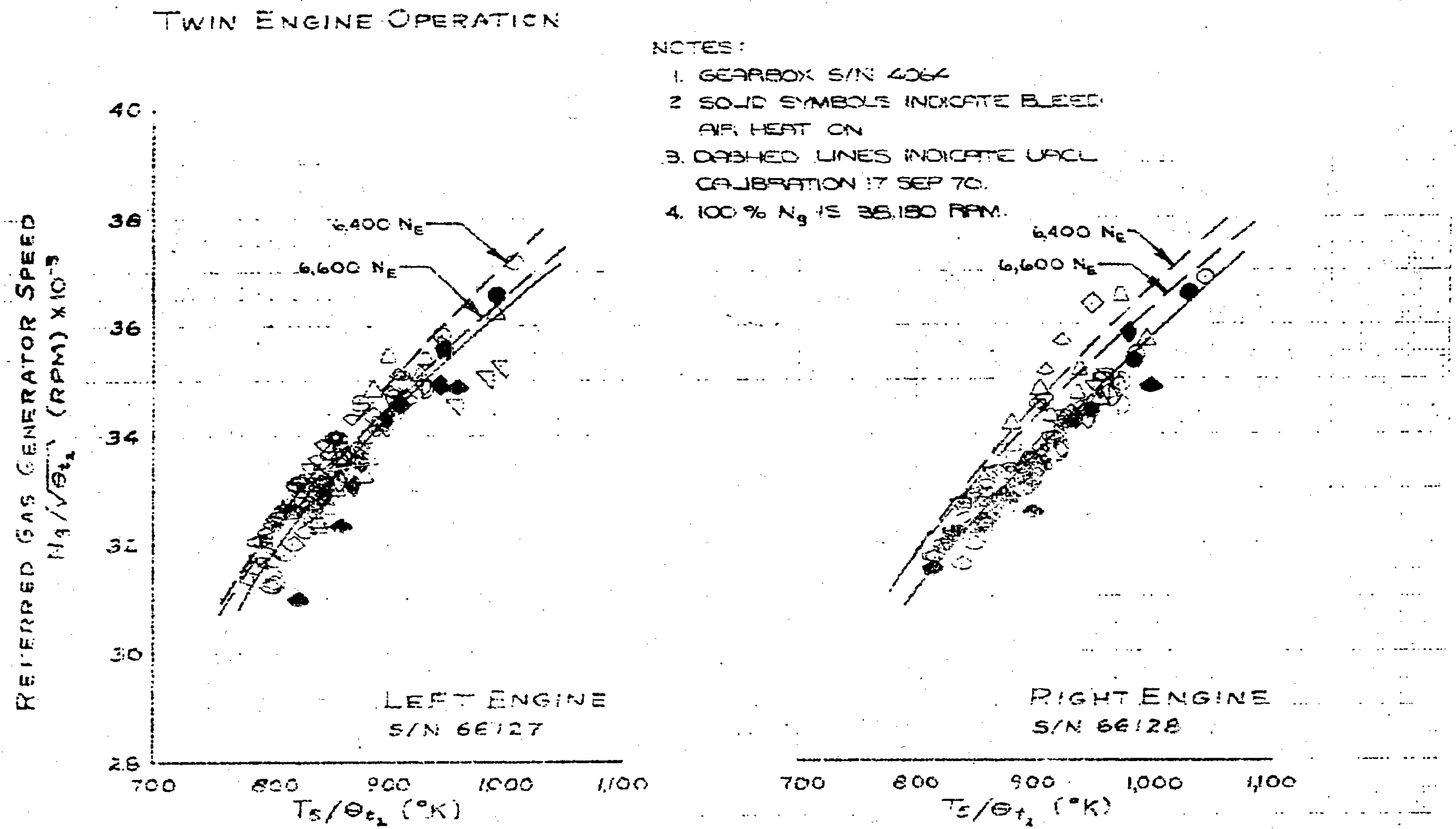


FIGURE 150 ENGINE CHARACTERISTICS

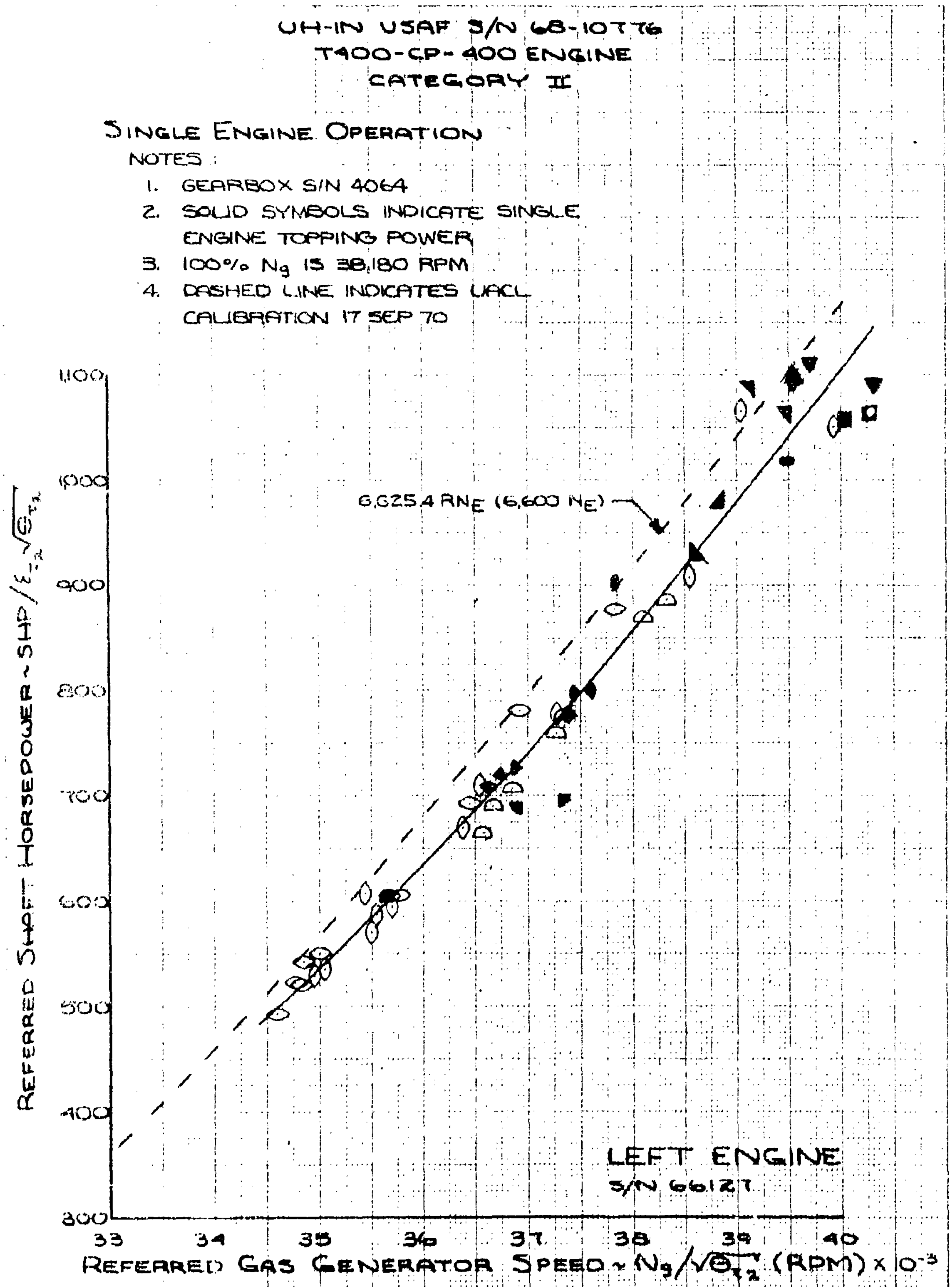


FIGURE 131 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES:

1. GEARBOX S/N 40[illegible]4
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER
3. DASHED LINE INDICATES [illegible] CALIBRATION 17 SEP 70

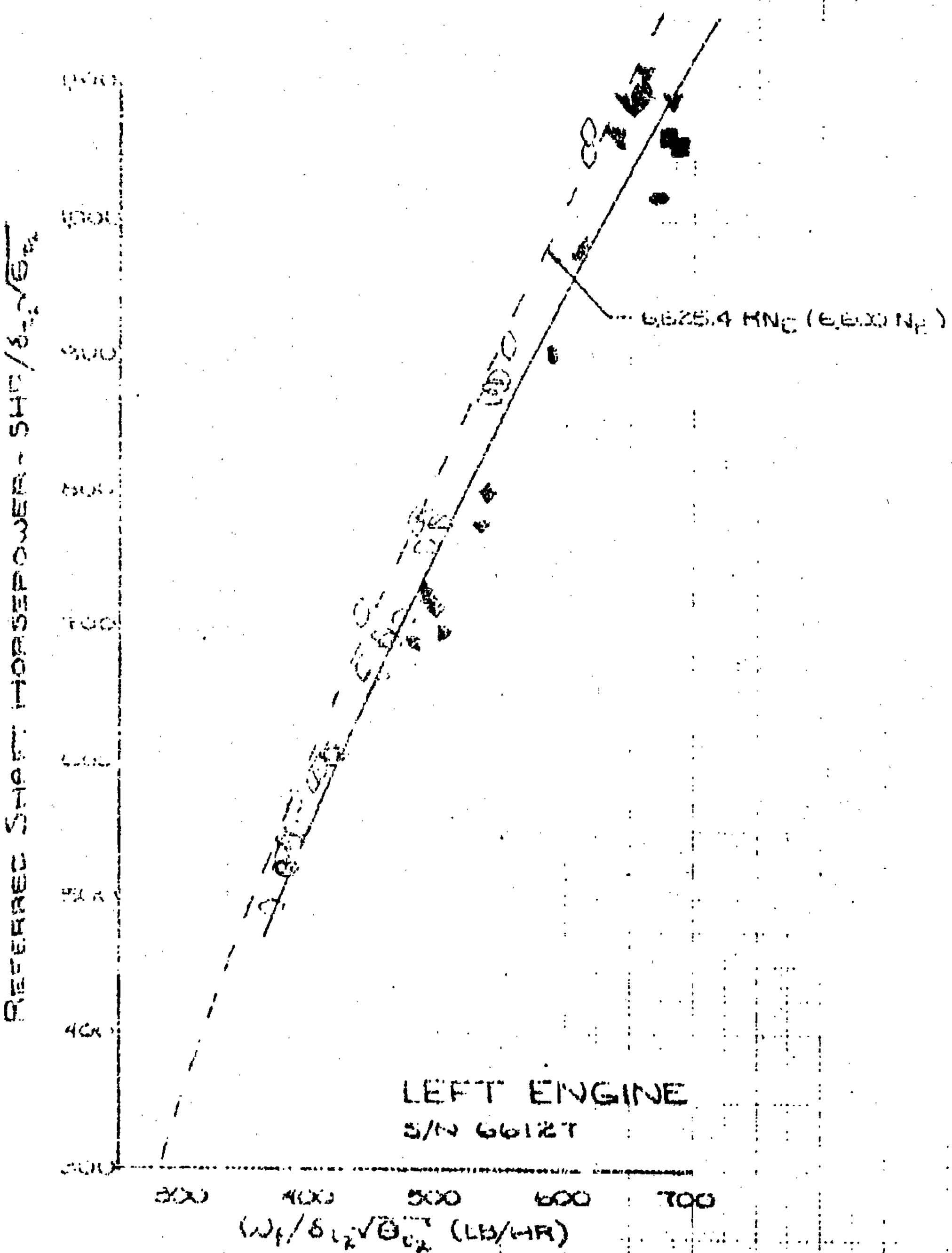


FIGURE 132 ENGINE CHARACTERISTICS

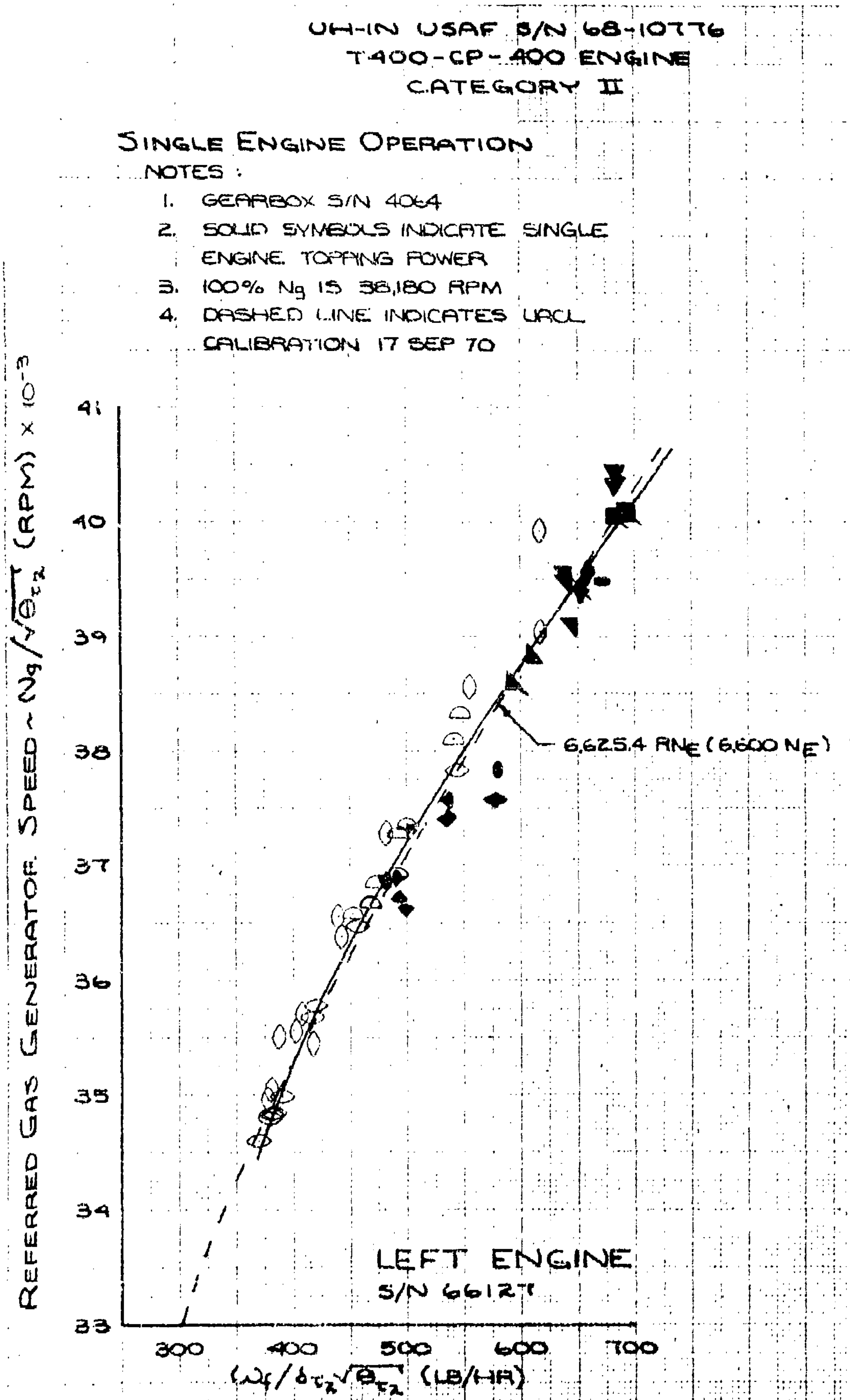


FIGURE 133 ENGINE CHARACTERISTICS

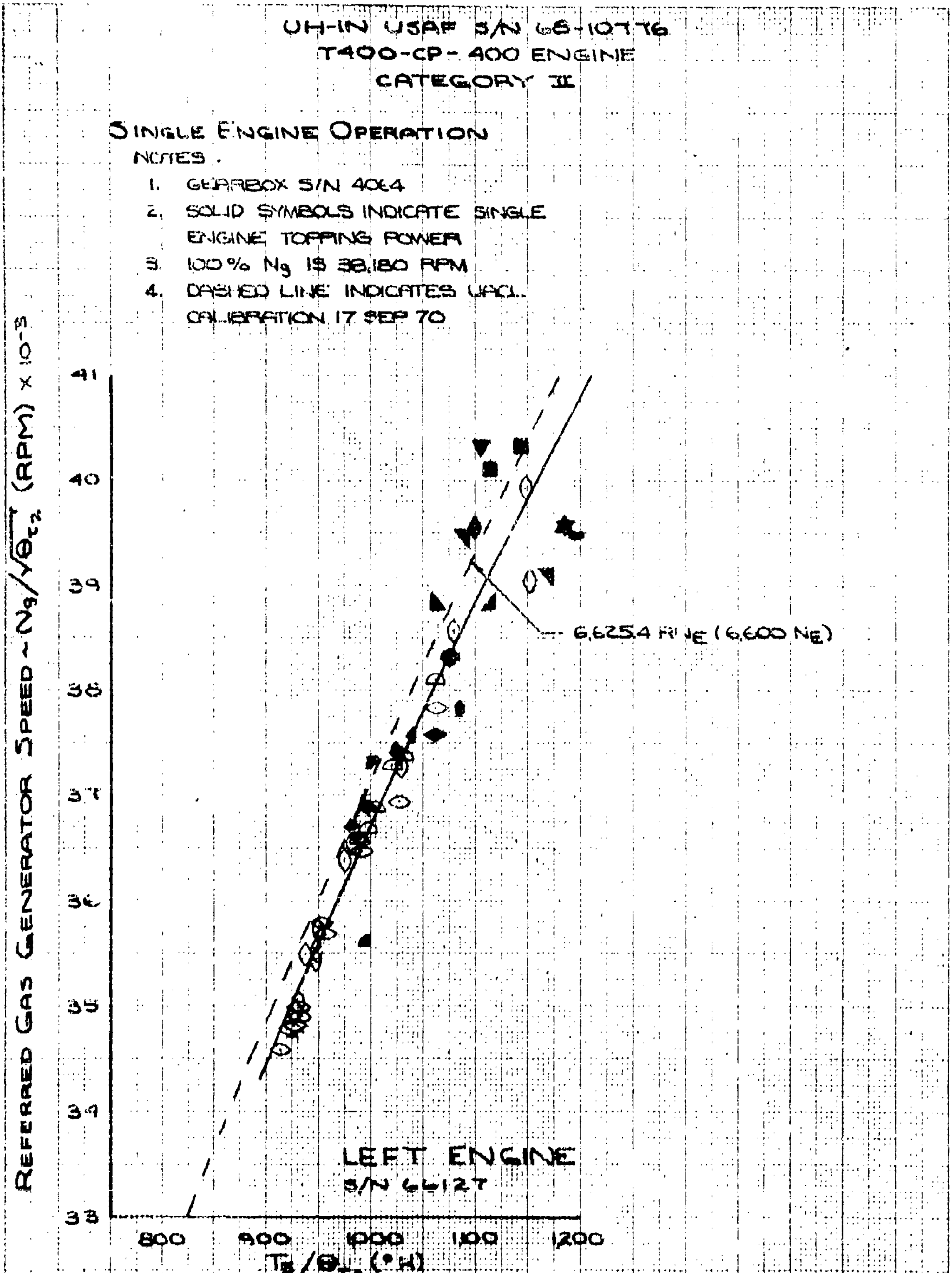


FIGURE 154 ENGINE CHARACTERISTICS

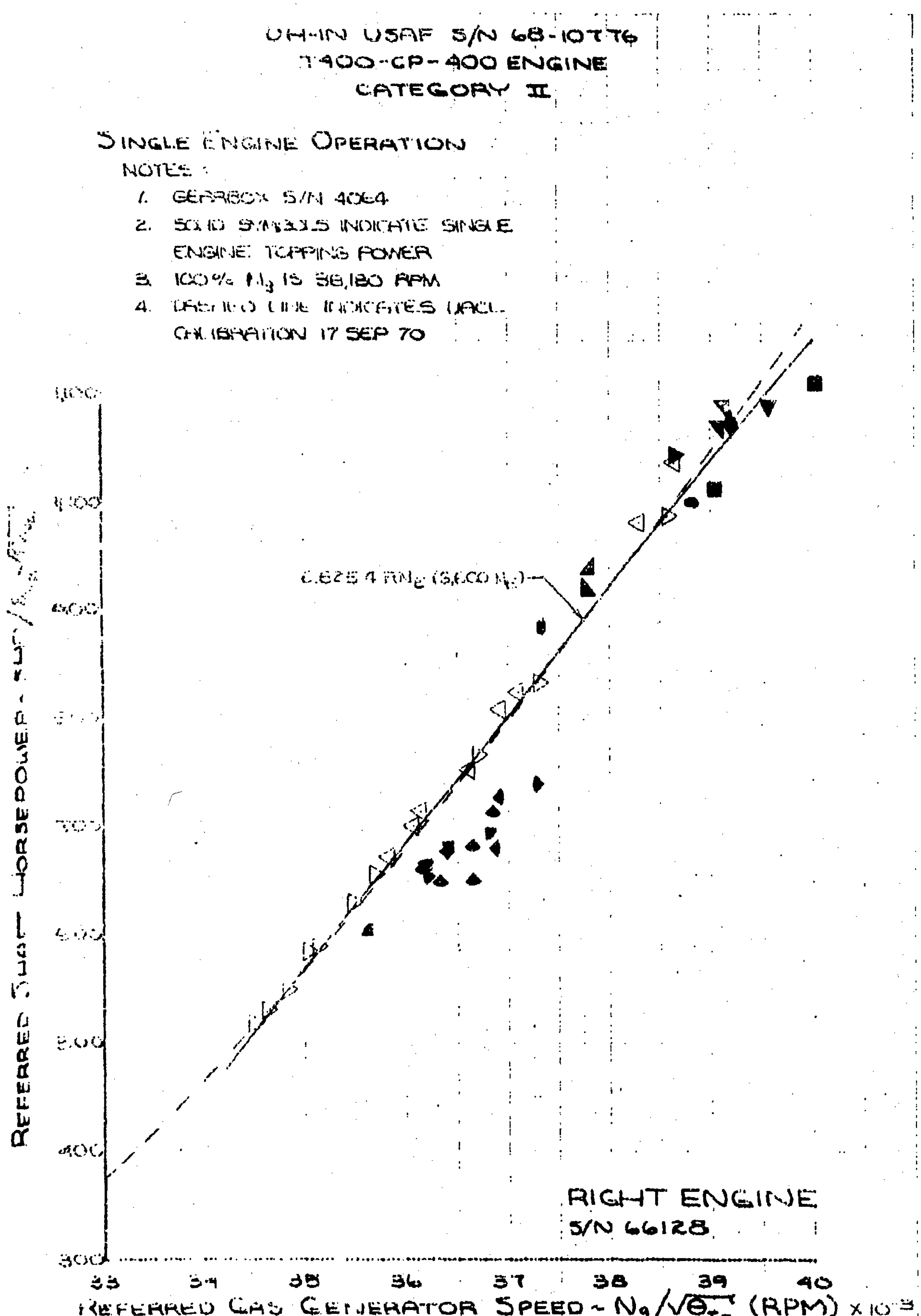


FIGURE 155 ENGINE CHARACTERISTICS

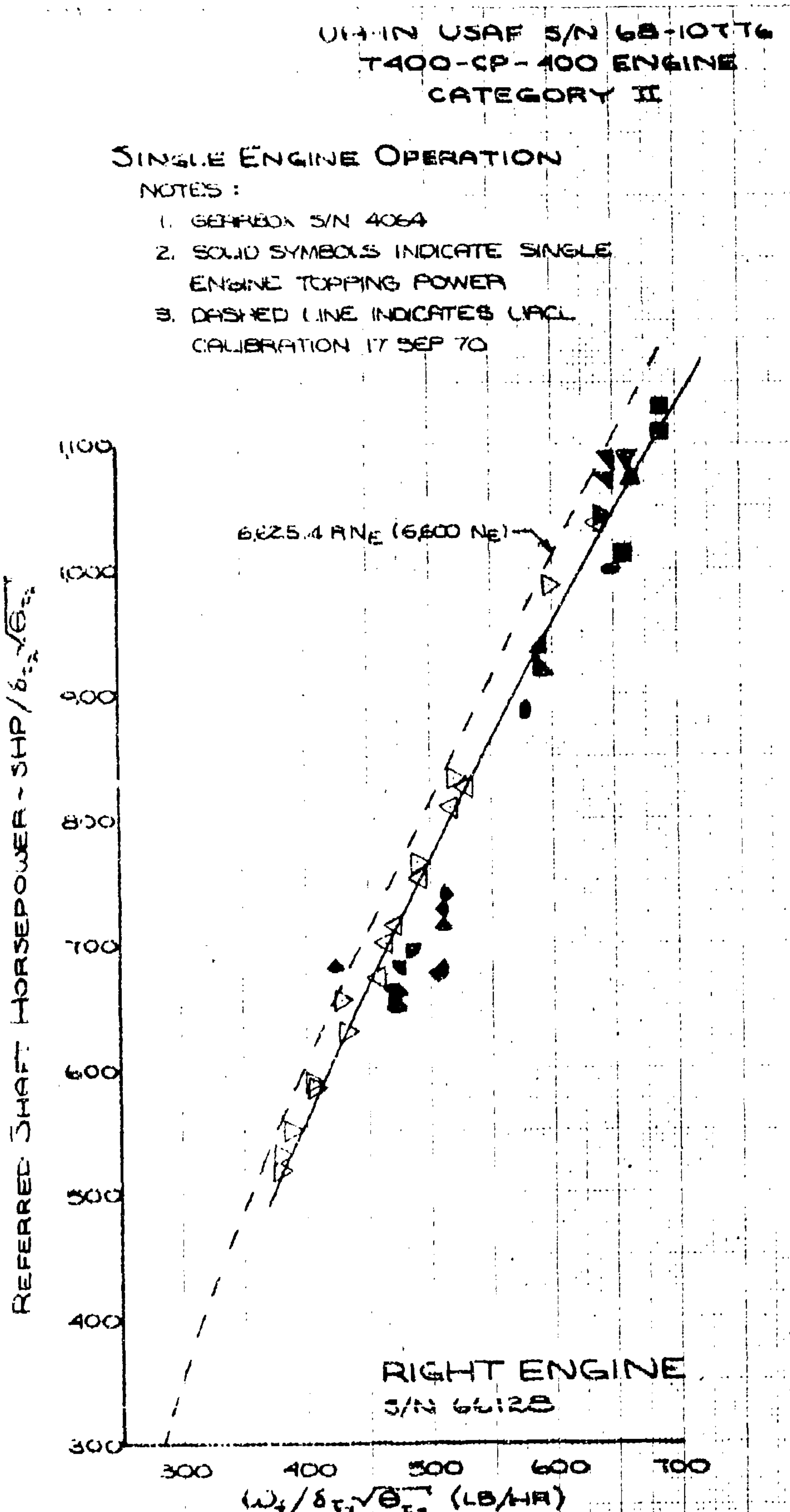


FIGURE 136 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES:

1. GEARBOX S/N 4024
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER
3. 100% N_g IS 38,120 RPM
4. DASHED LINE INDICATES UACL CALIBRATION 17 SEP 70

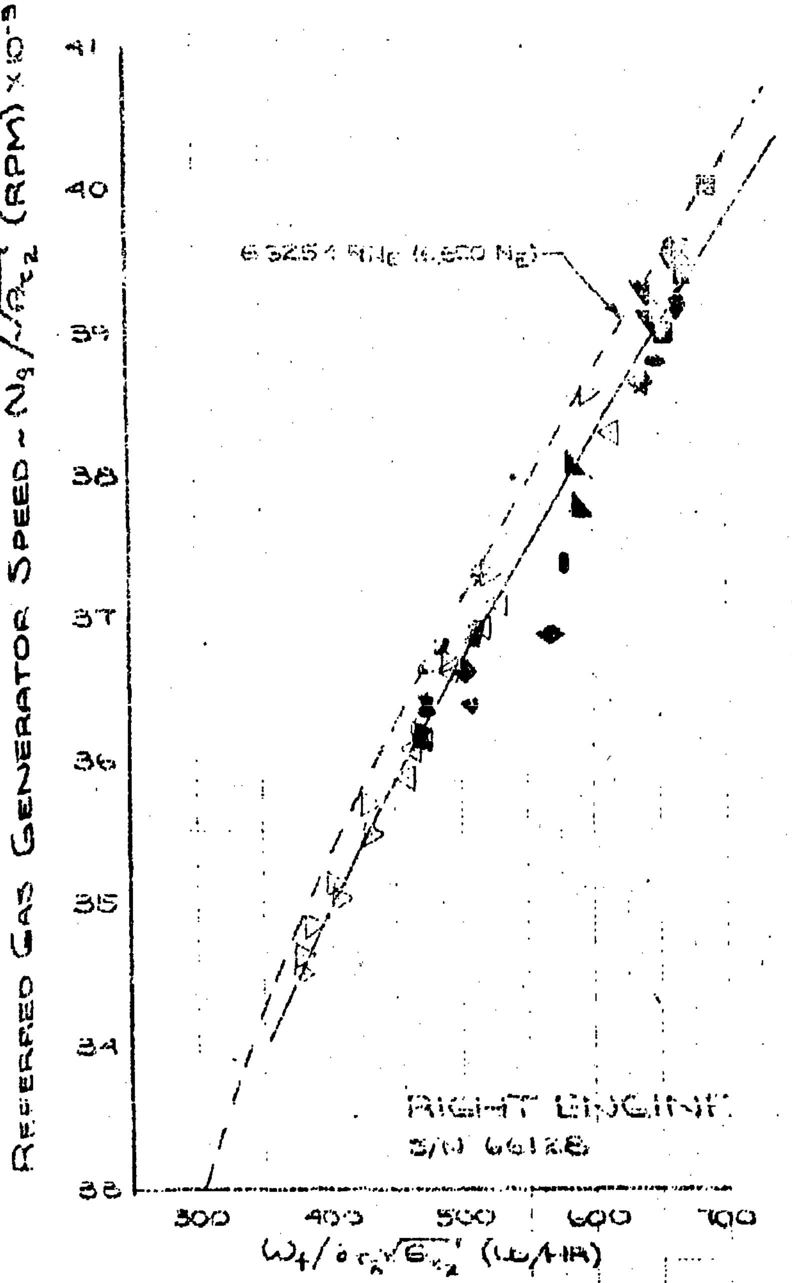


FIGURE 157 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES:

1. GEARBOX S/N 4064
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER
3. 100% Ng IS 38,180 RPM
4. DASHED LINE INDICATES UACL CALIBRATION 17 SEP 70

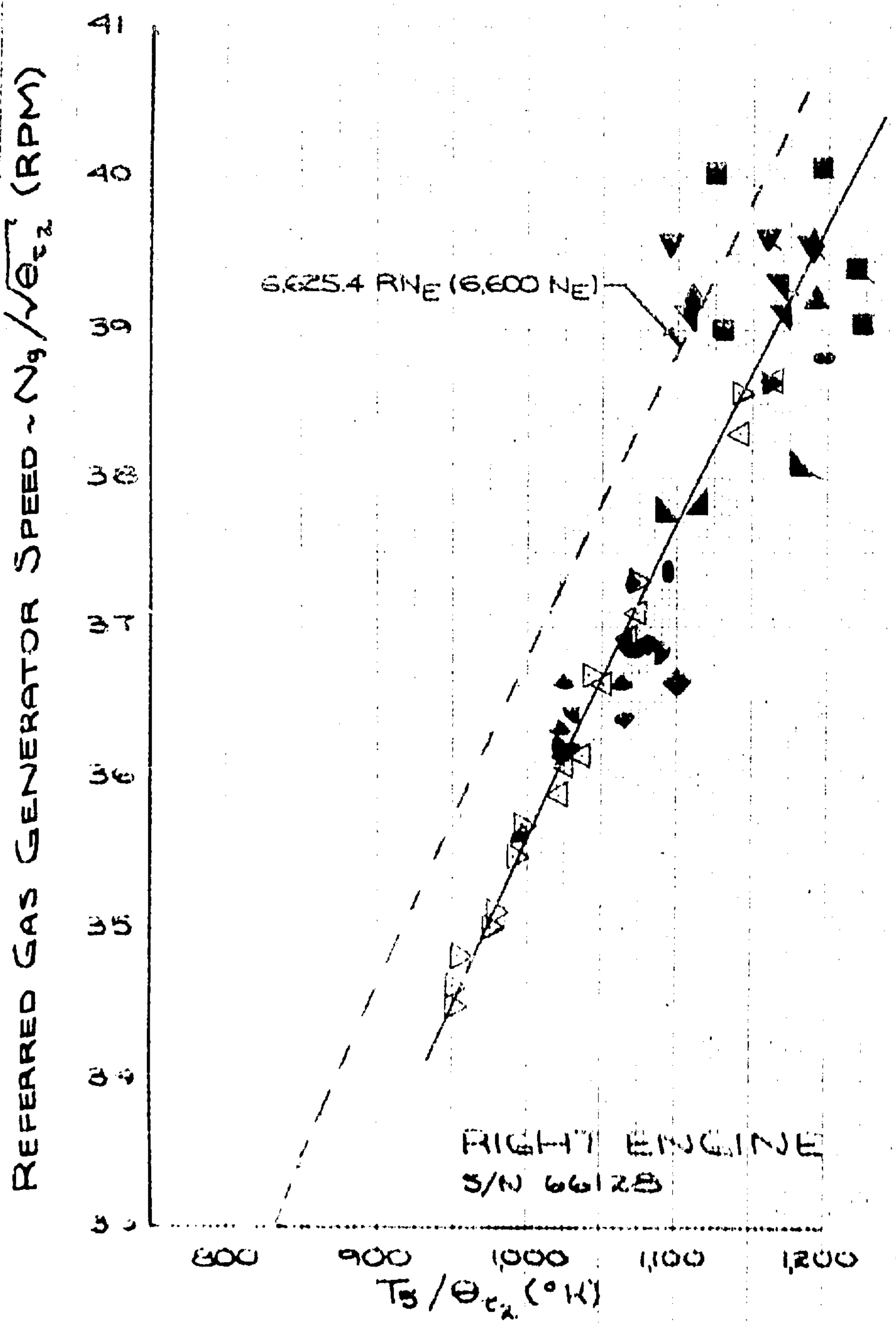


FIGURE 138 ENGINE CHARACTERISTICS

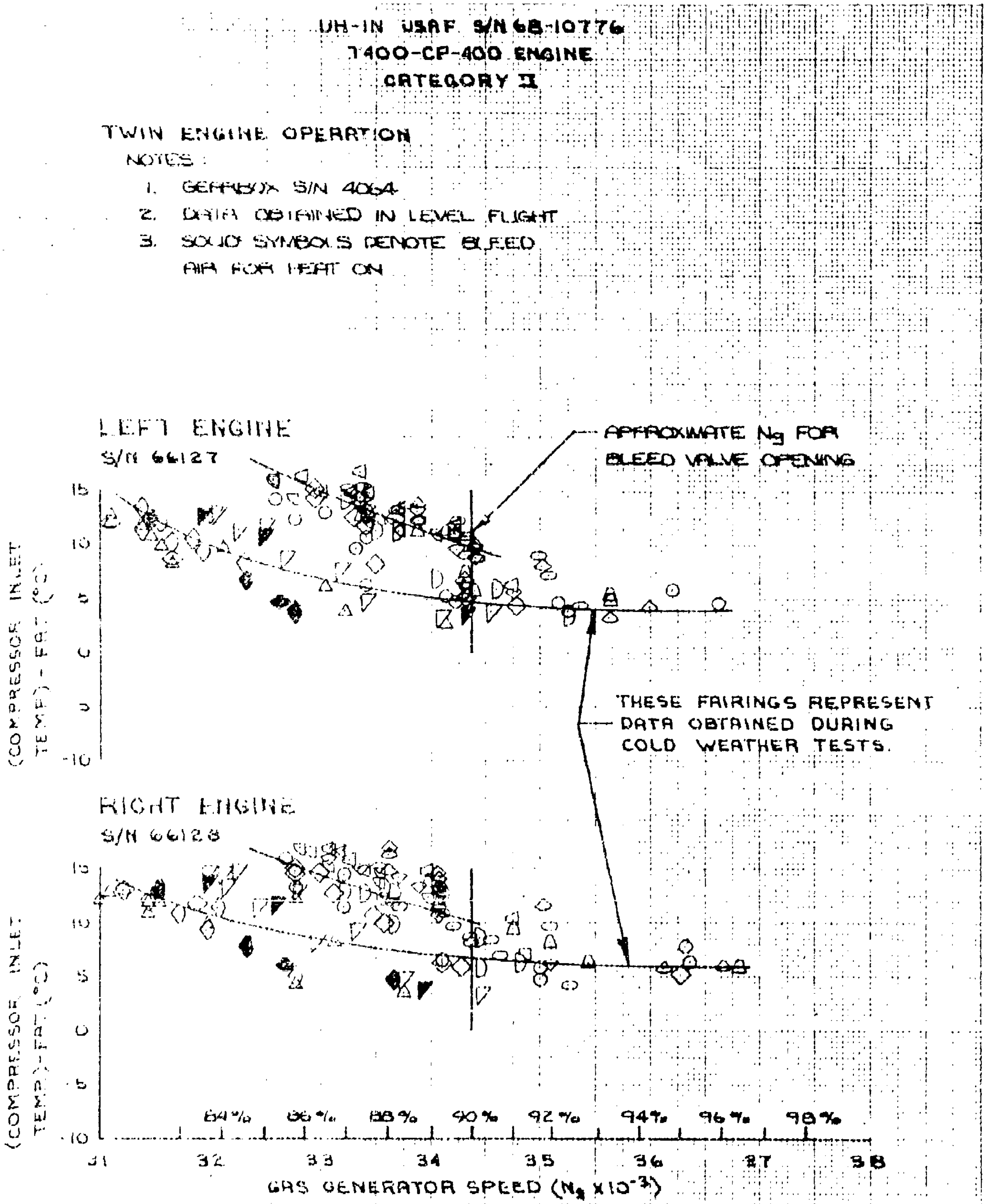


FIGURE 129 ENGINE INLET CHARACTERISTICS

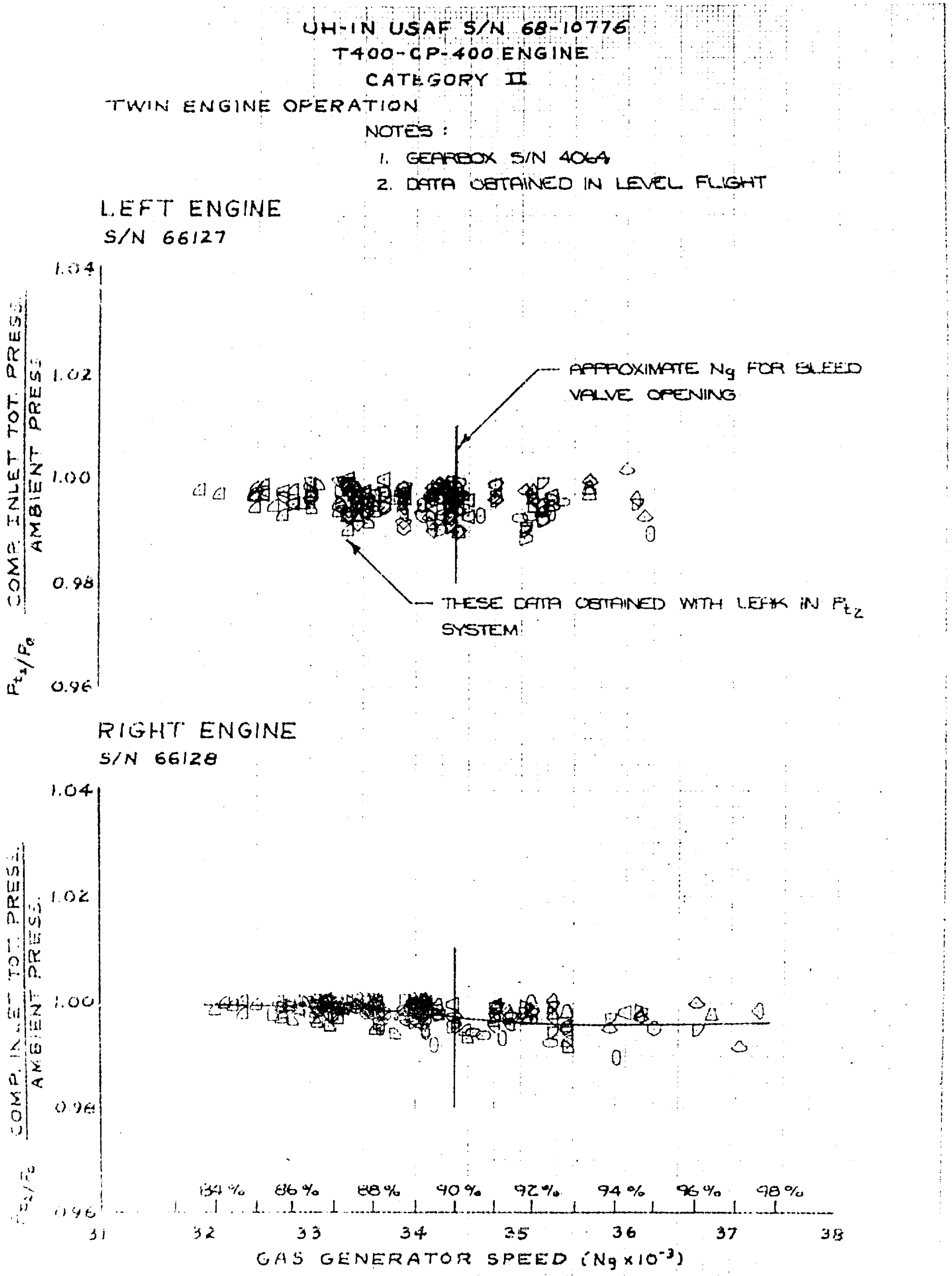


FIGURE 140 ENGINE INLET CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

TWIN ENGINE OPERATION
NOTE:
1. DATA OBTAINED IN HOVER
2. GEARBOX S/N 4064

SYMBOL	SKID HEIGHT (FT)
○	2
□	4
△	10
◇	15
⌂	25
○	35
□	60
▽	100

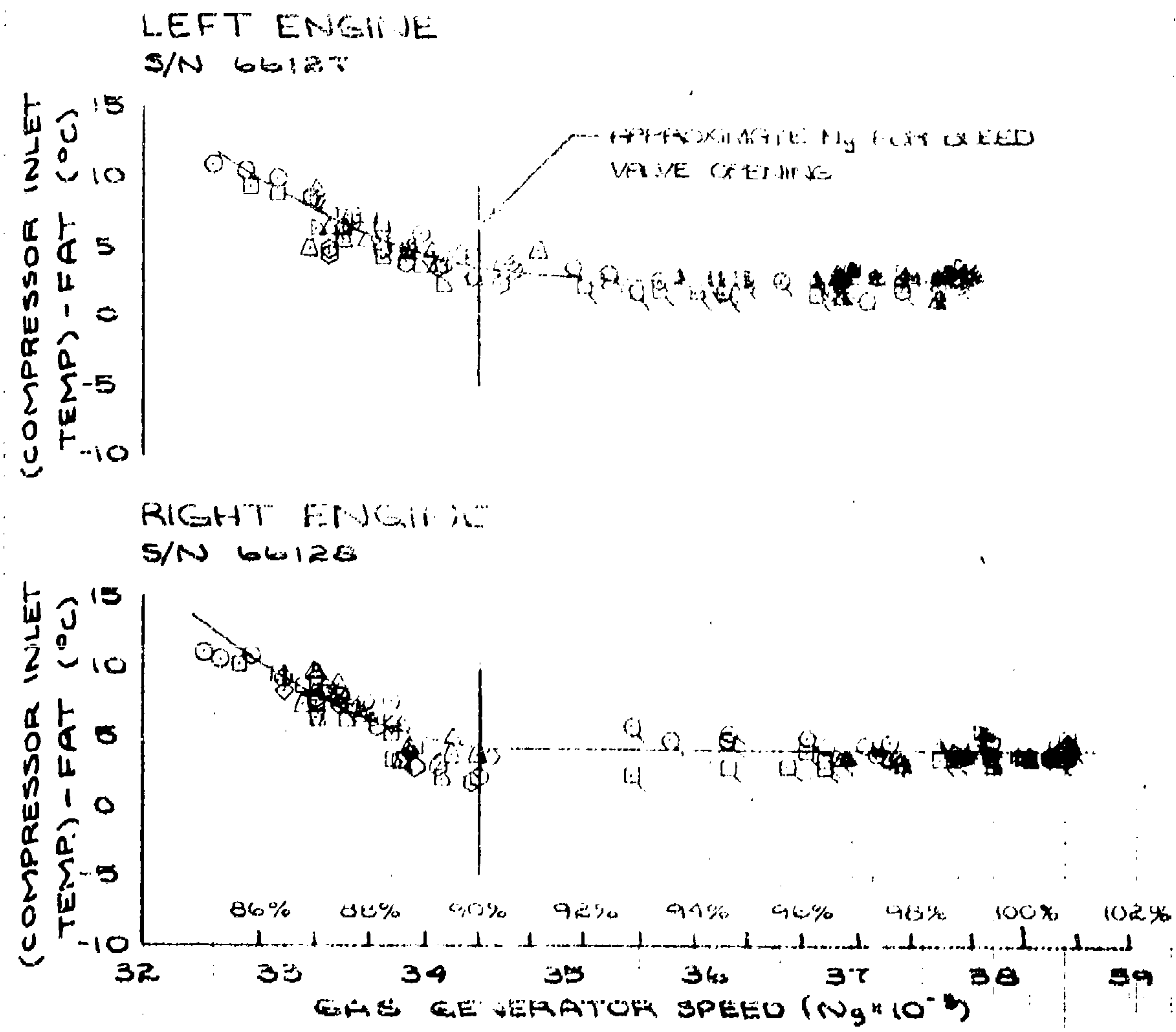


FIGURE 141 ENGINE INLET CHARACTERISTICS

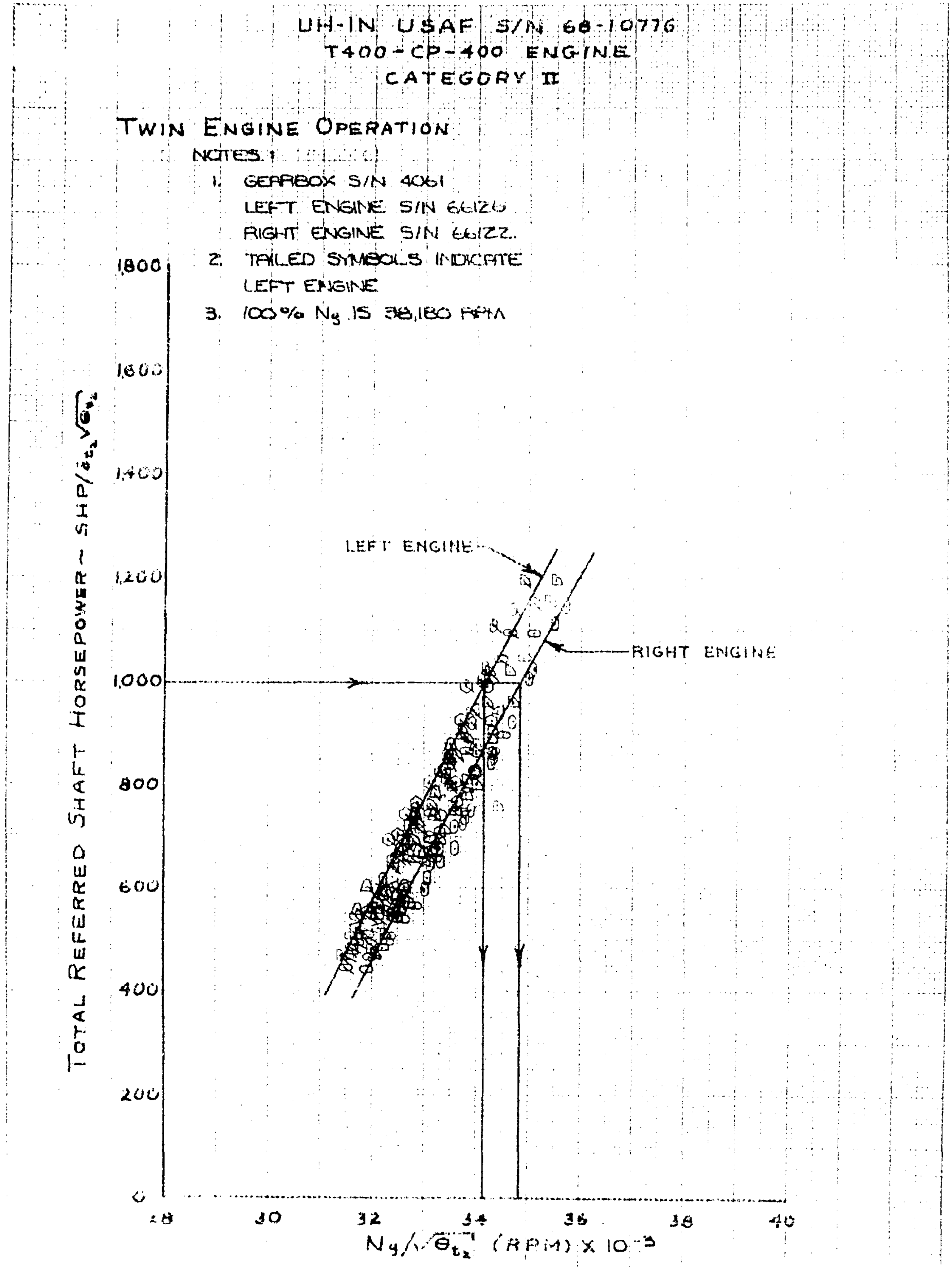


FIGURE 142. ENGINE CHARACTERISTICS

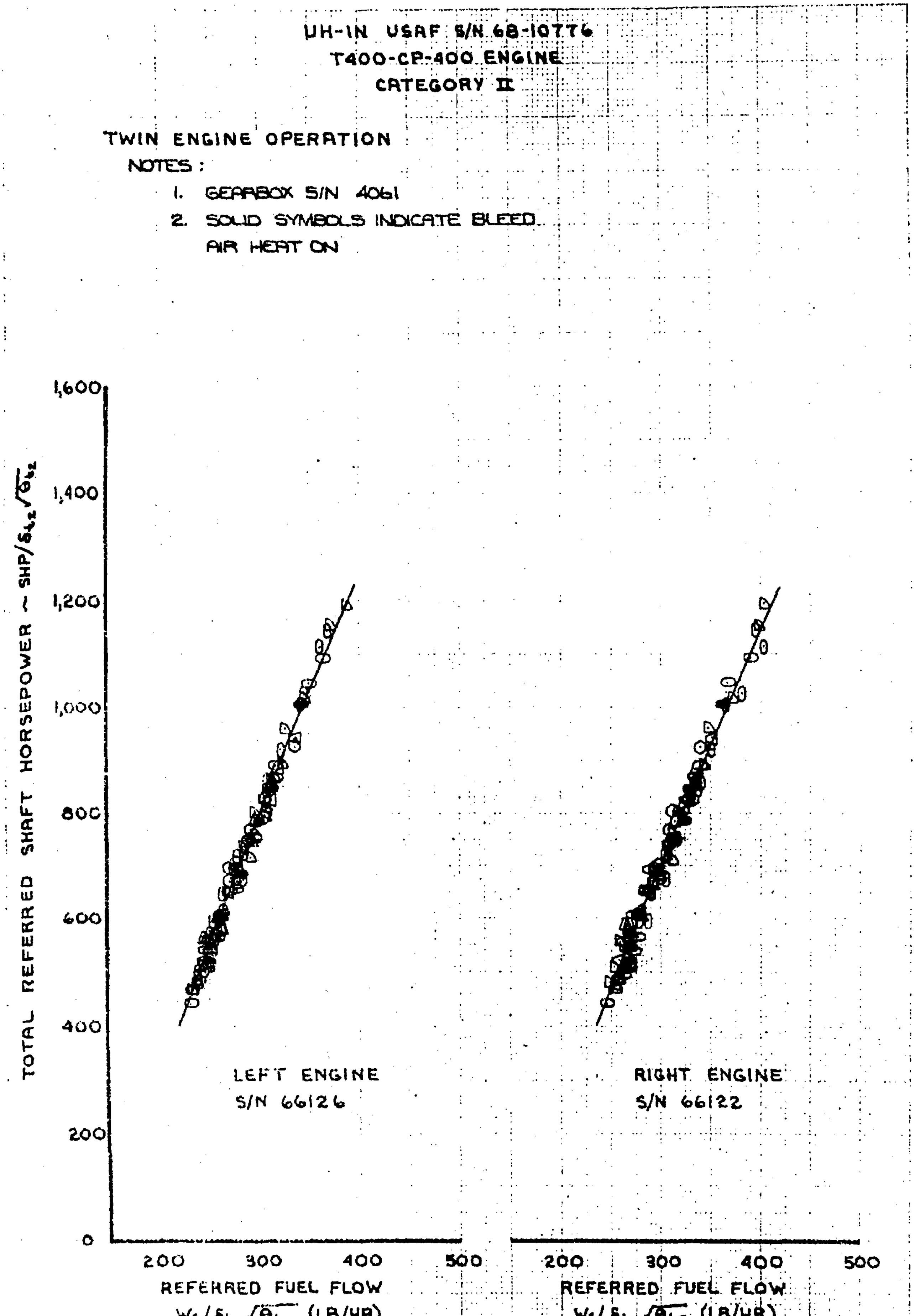


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FIGURE 143 ENGINE CHARACTERISTICS

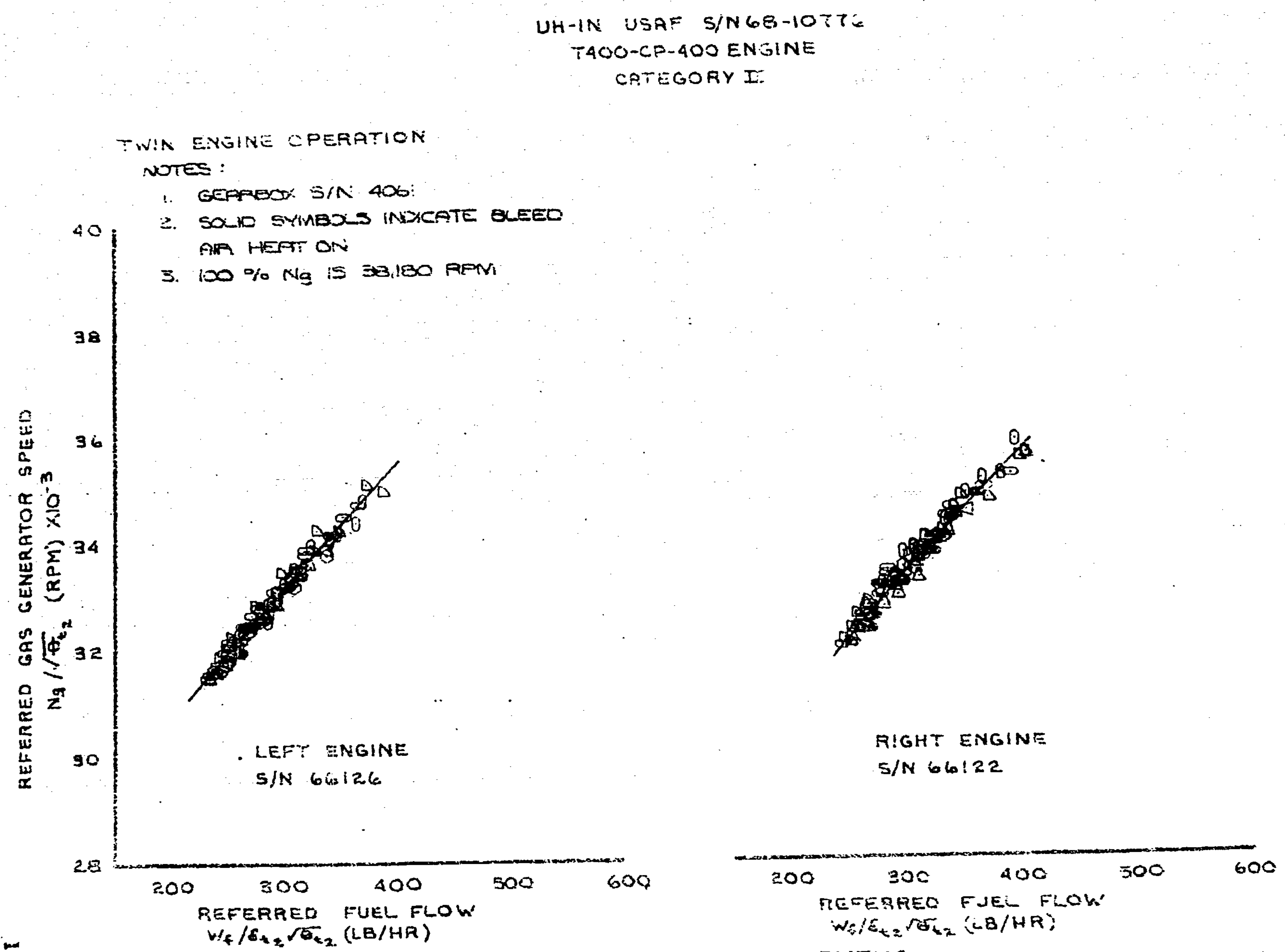


FIGURE 144 ENGINE CHARACTERISTICS

UH-IN USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

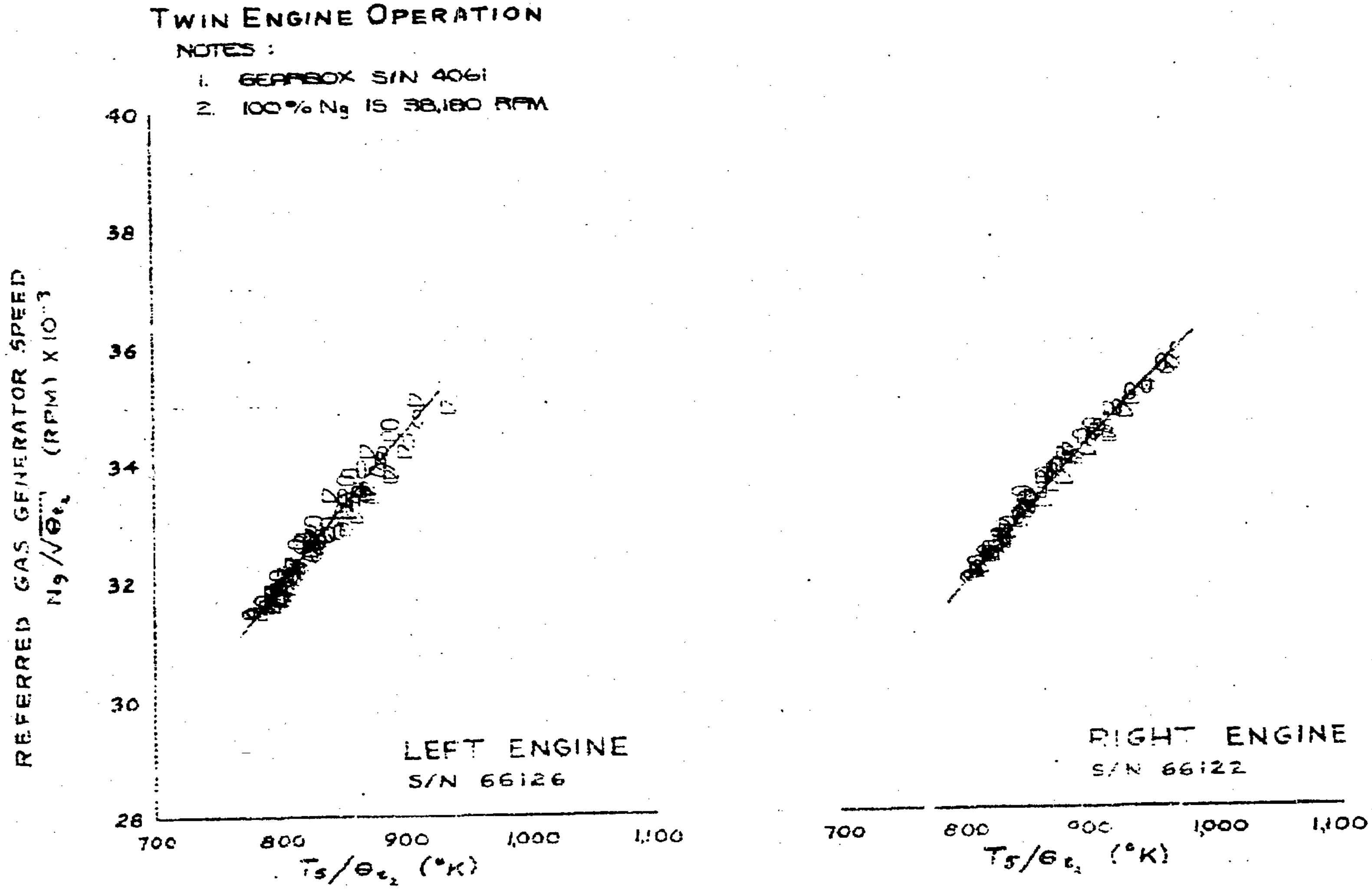


FIGURE 145 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES :

1. GEARBOX S/N 4061
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER
3. 100% Ng IS 38,180 RPM

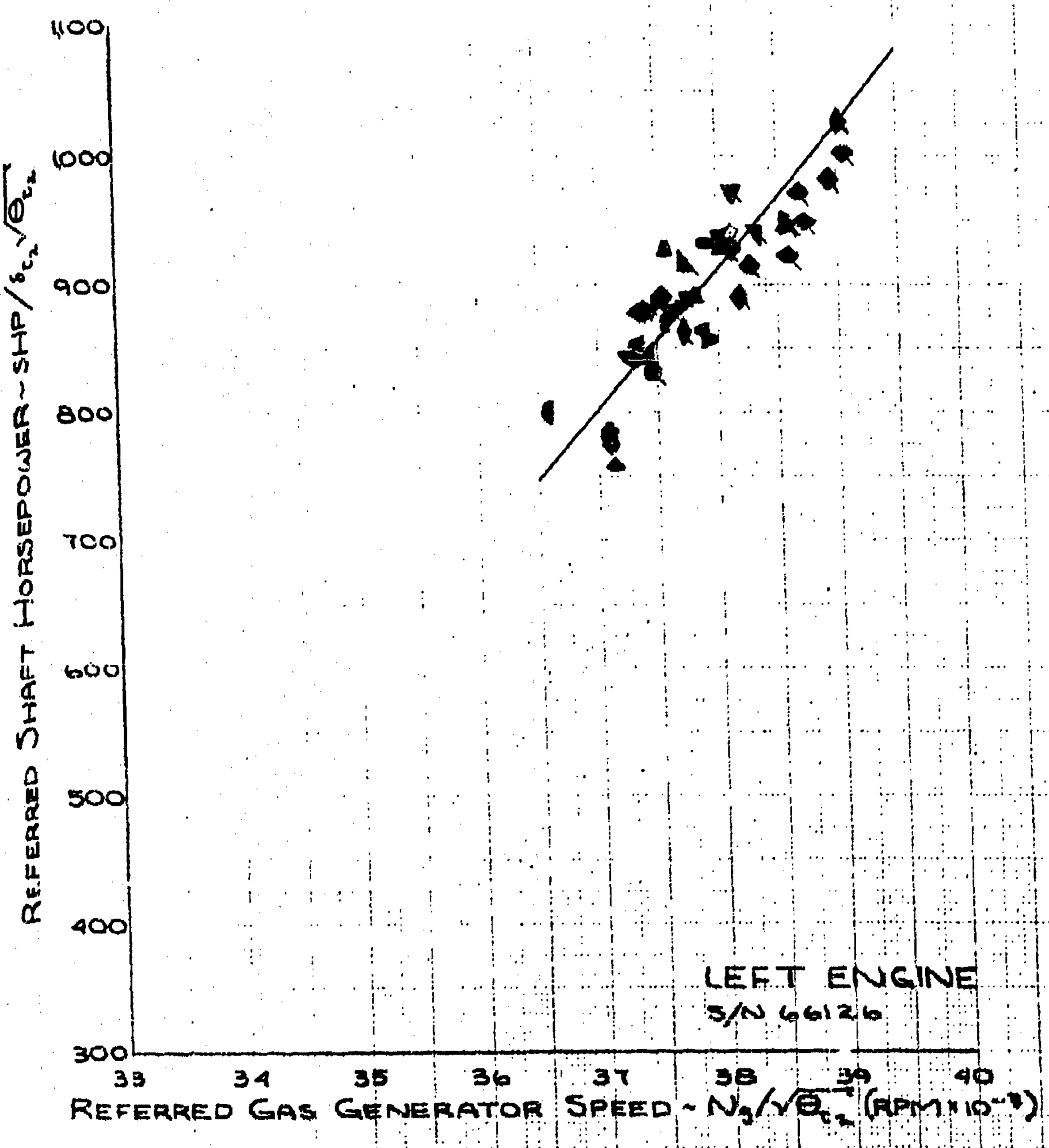


FIGURE 146 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES:

1. GEARBOX S/N 4061
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER

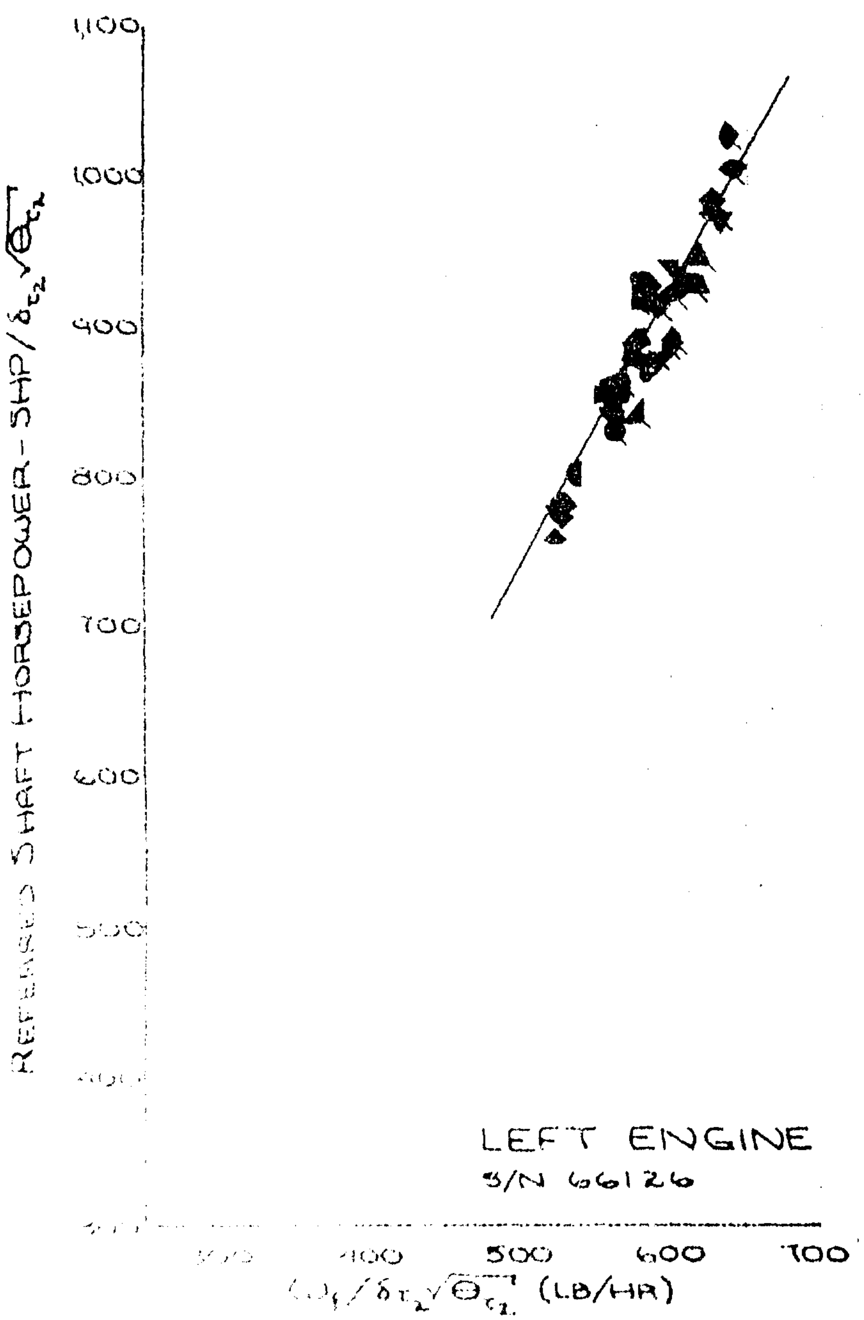


FIGURE 47 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES:

1. GEARBOX S/N 4061
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER
3. 100 % N_g IS 38,180 RPM

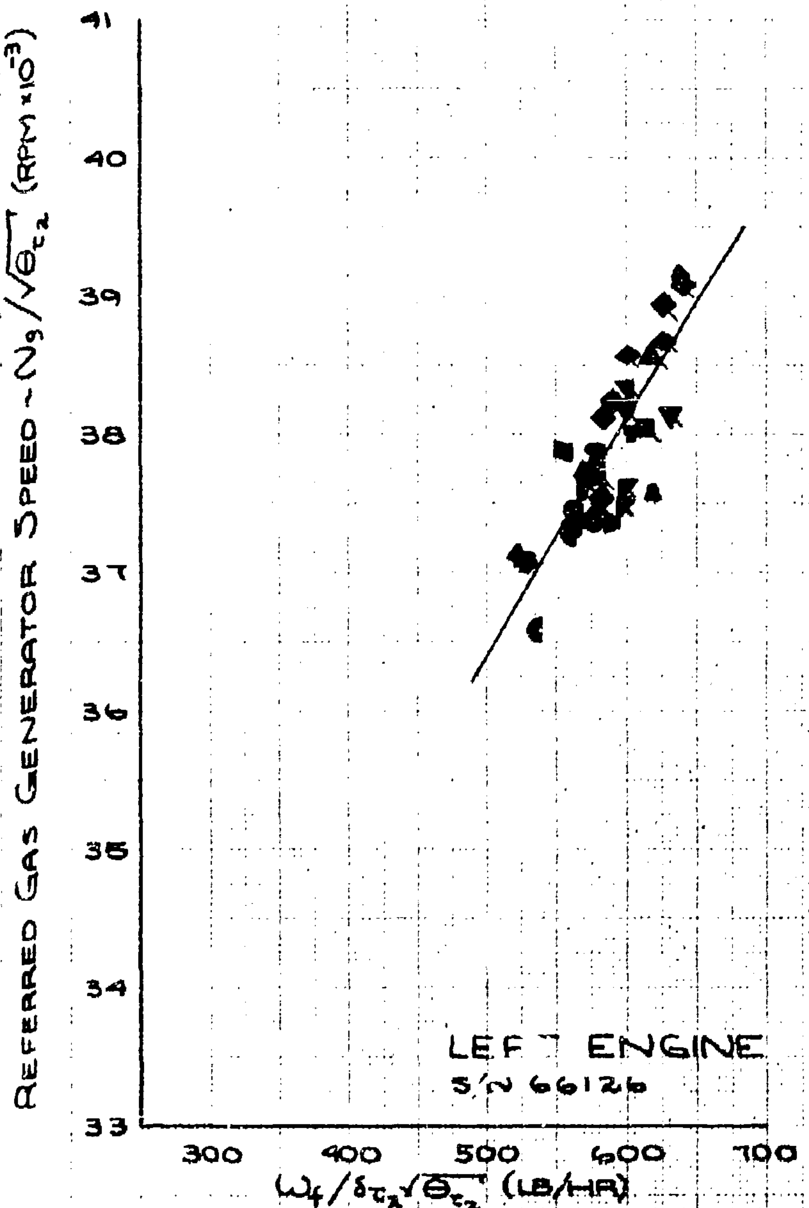


FIGURE 148 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES :

1. GEARBOX S/N 4061
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER
3. 100% N_g IS 38,180 RPM

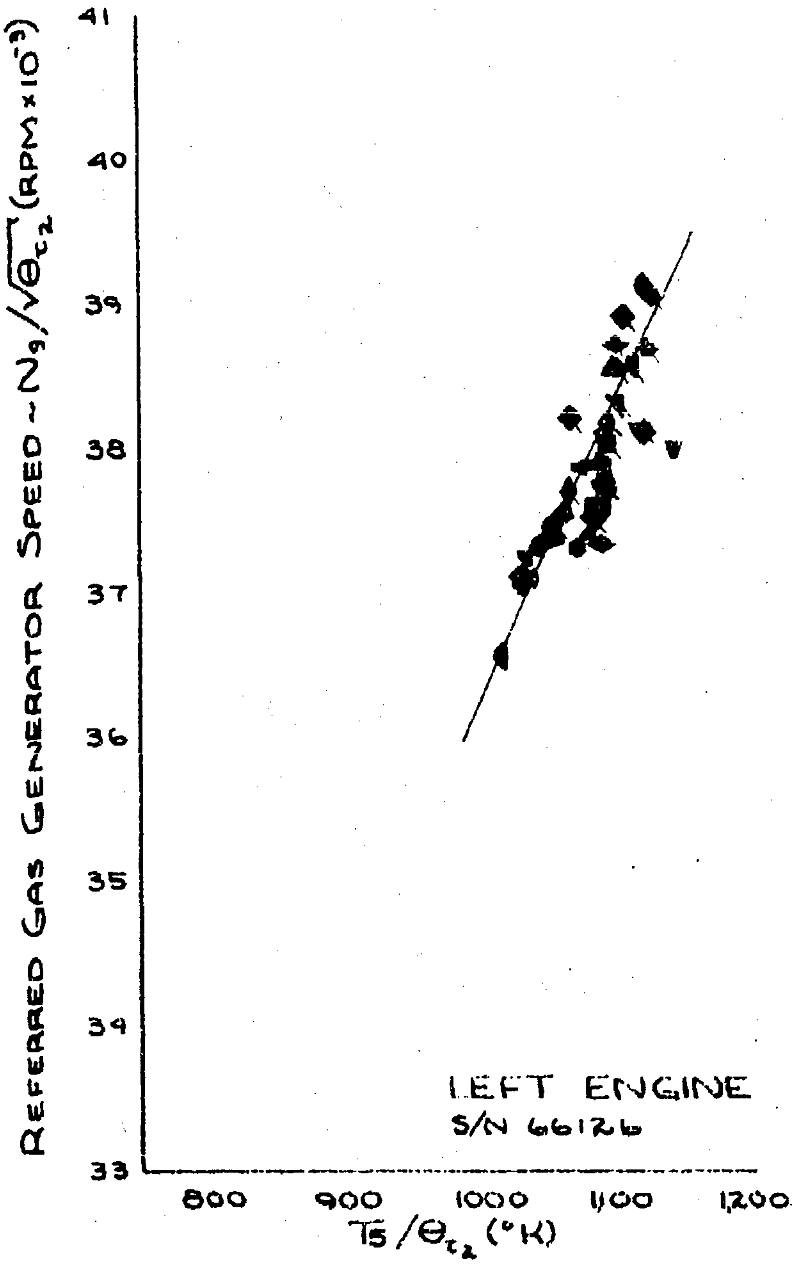


FIGURE 149 · ENGINE CHARACTERISTICS

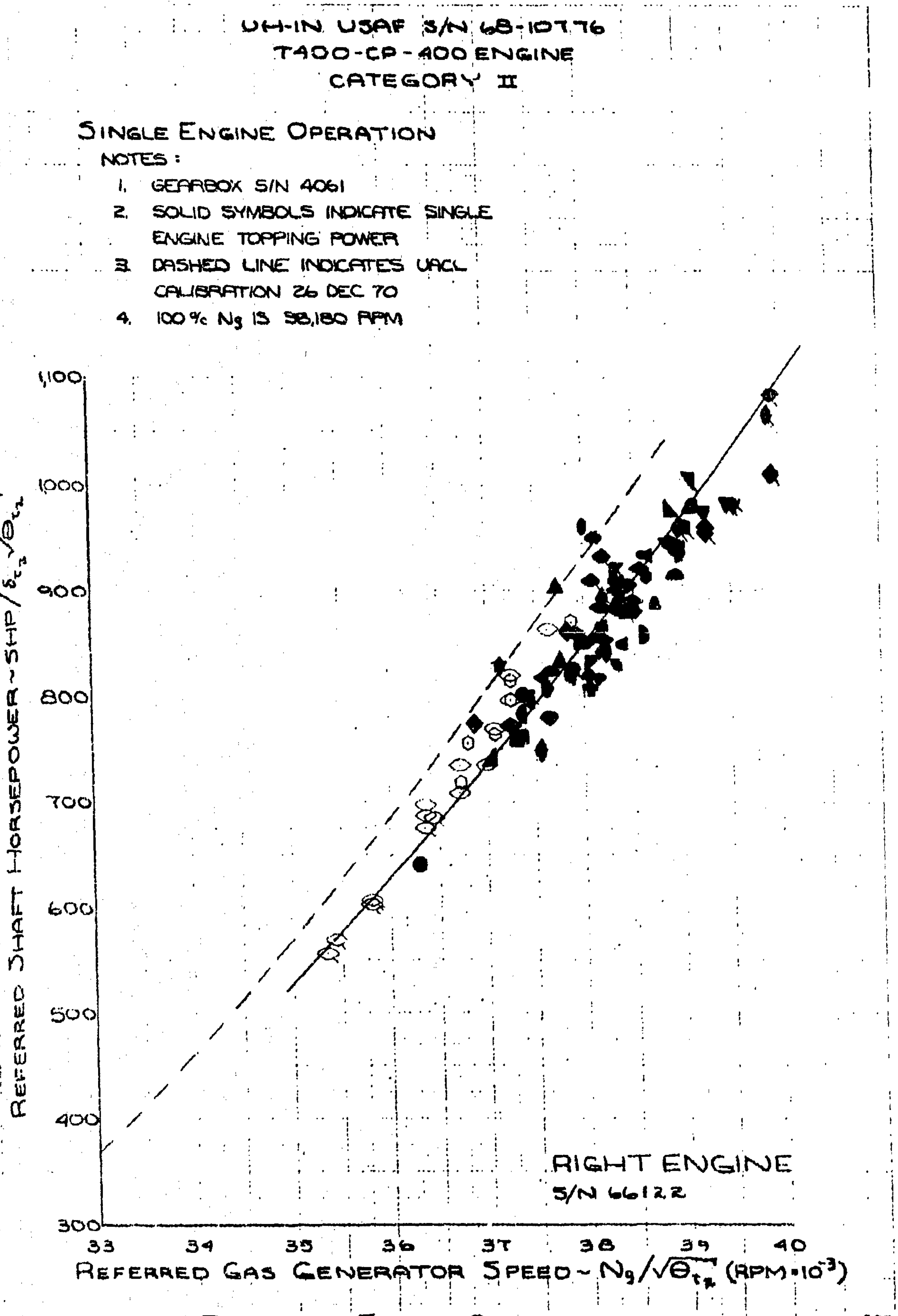


FIGURE 150 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

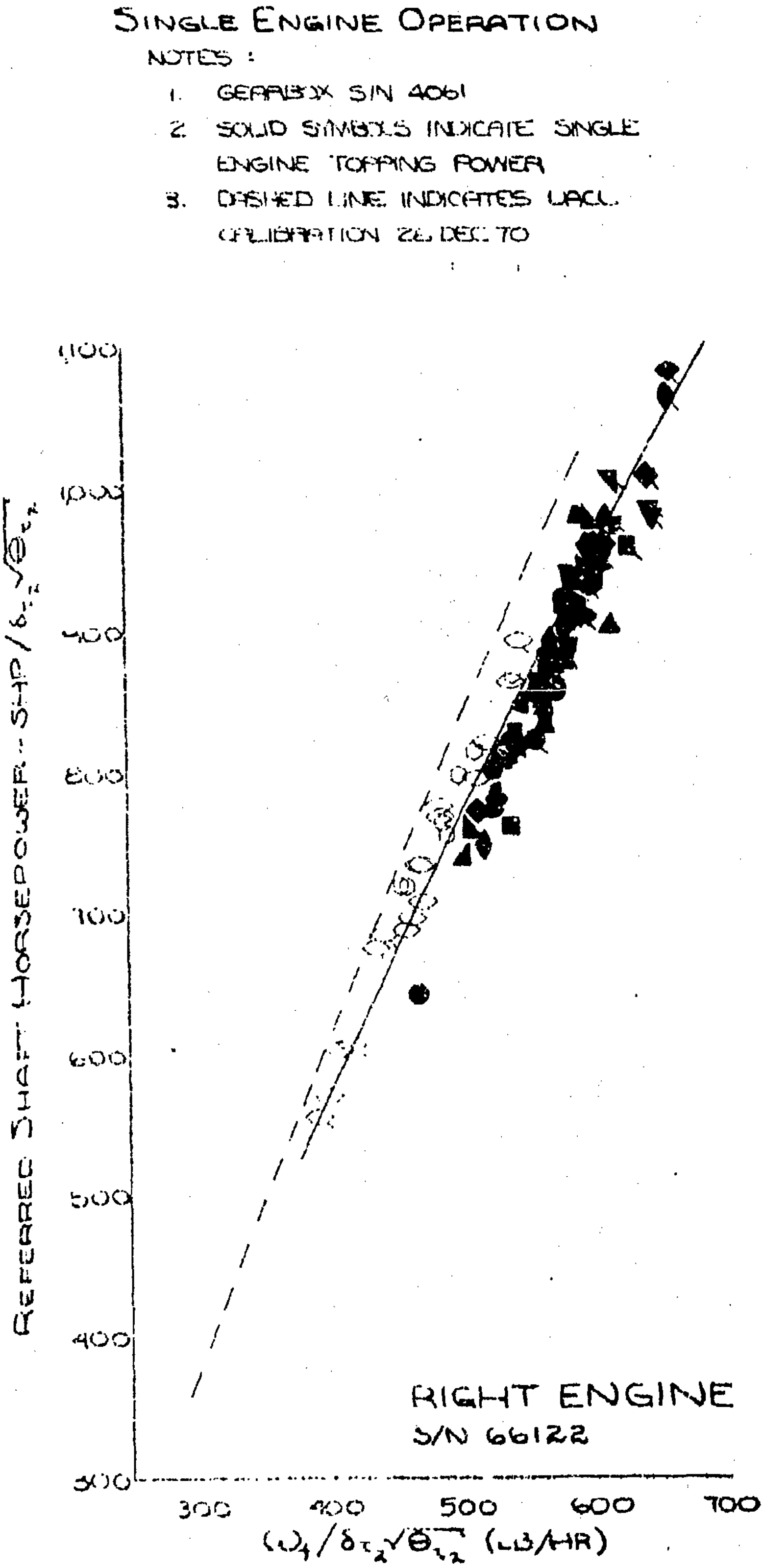


FIGURE 151 · ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES :

1. GEARBOX S/N 4061
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER
3. DASHED LINE INDICATES UACL CALIBRATION 26 DEC 70
4. 100% N_g IS 38,180 RPM

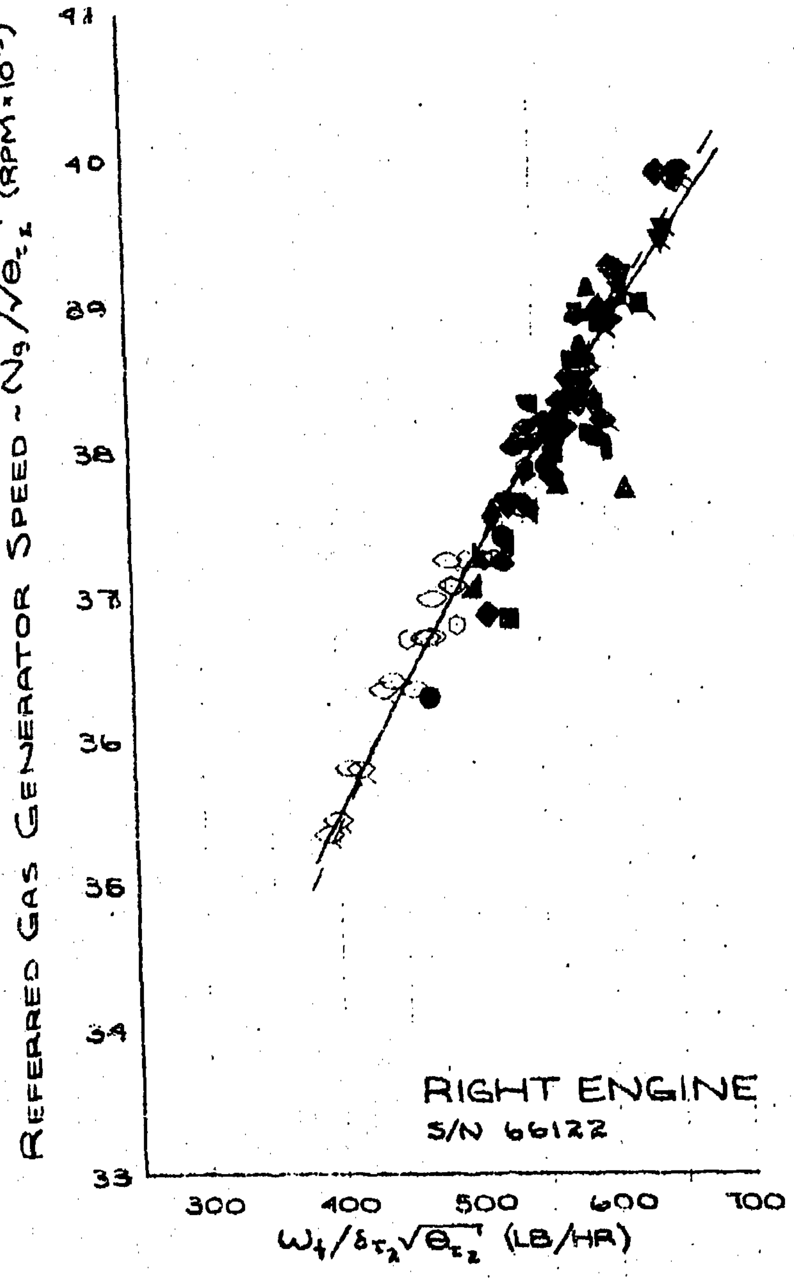


FIGURE 152 · ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

SINGLE ENGINE OPERATION

NOTES :

1. GEARBOX S/N 4061
2. SOLID SYMBOLS INDICATE SINGLE ENGINE TOPPING POWER
3. DASHED LINE INDICATES UACL CALIBRATION 26 DEC 70
4. 100 % Ng IS 38,180 RPM

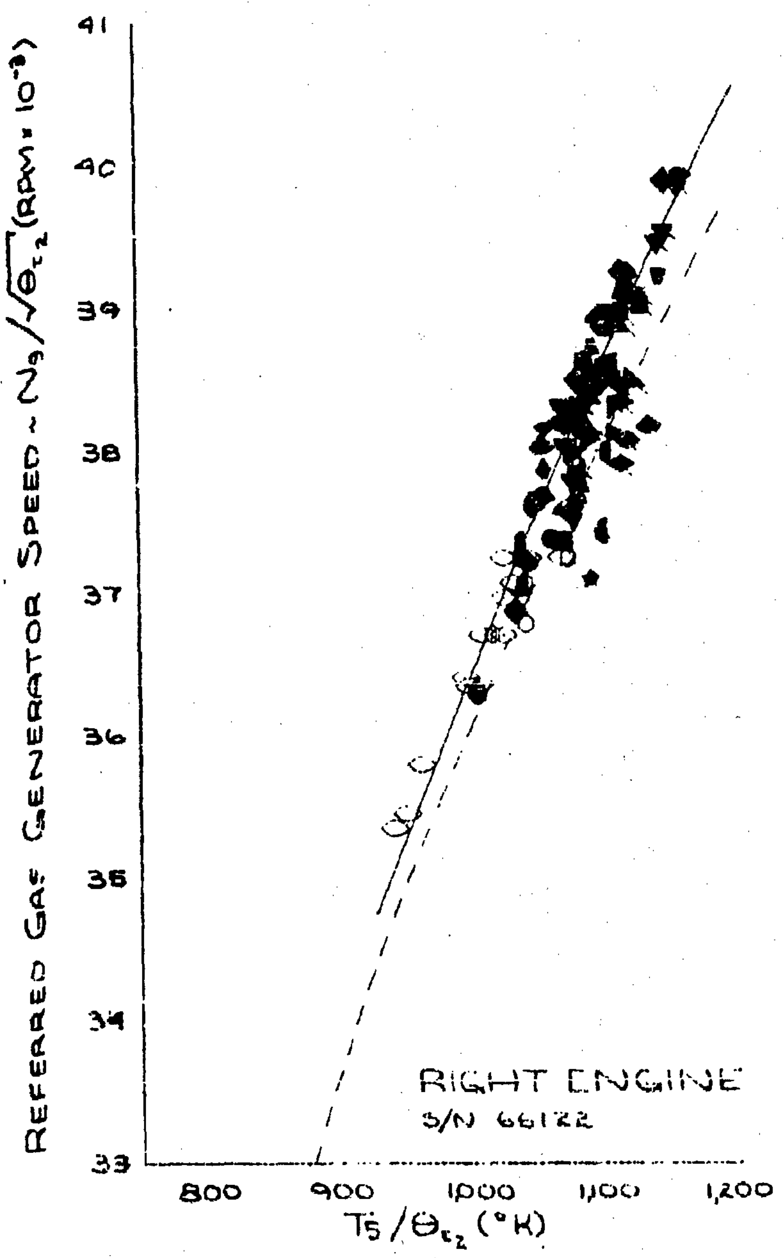


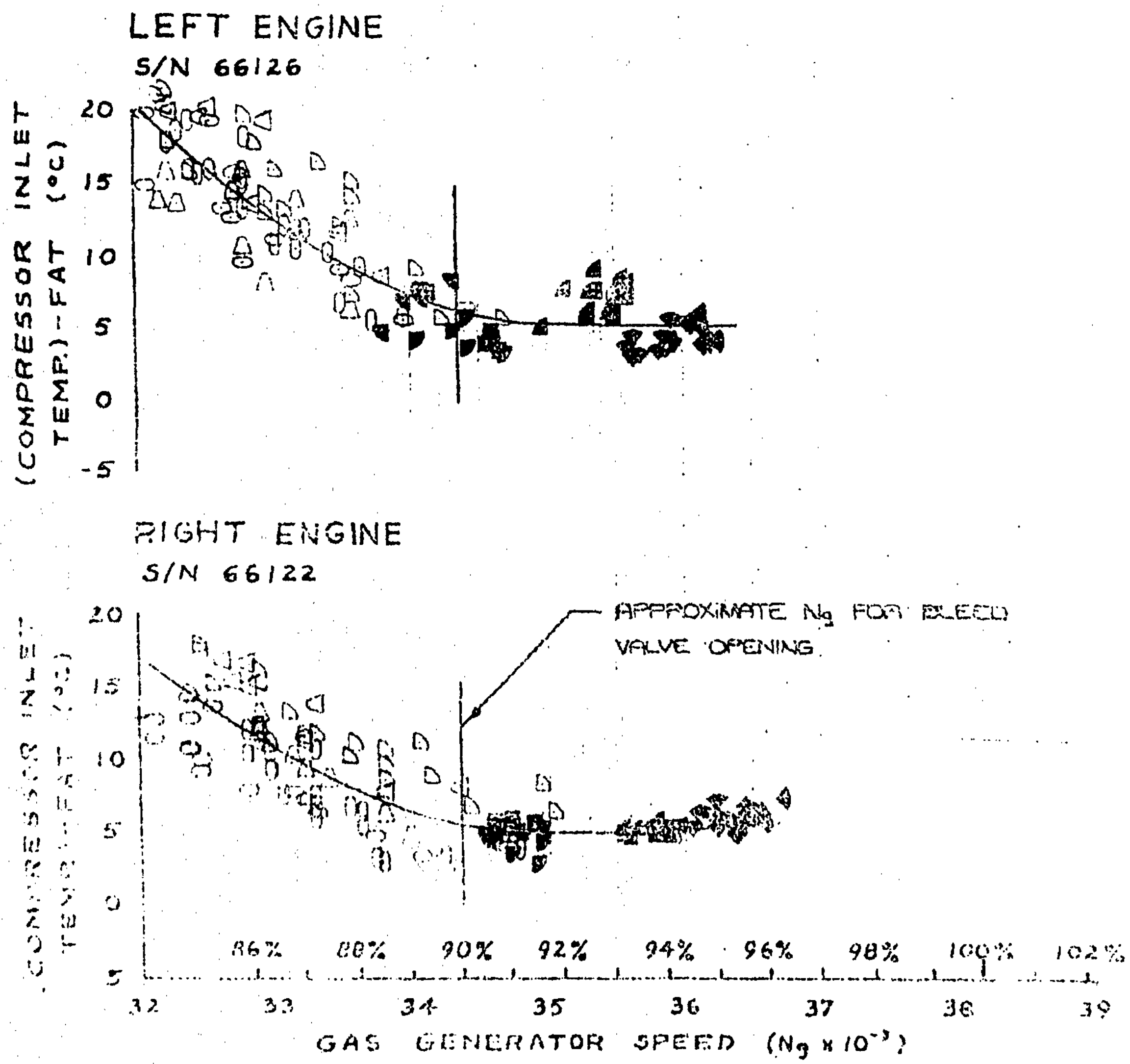
FIGURE 153 ENGINE CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

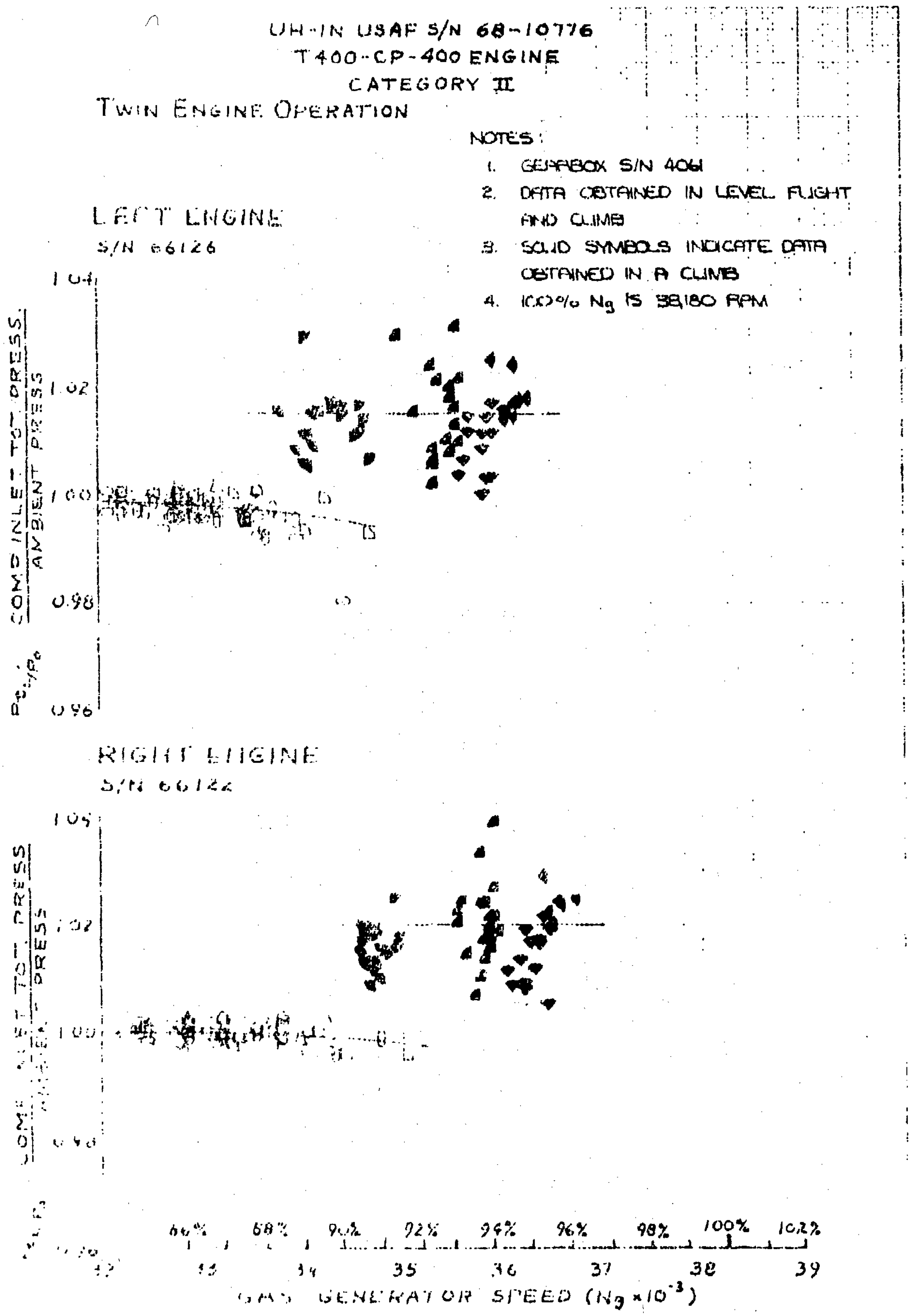
TWIN ENGINE OPERATION

NOTES:

1. GEARBOX S/N 4061
2. DATA OBTAINED IN LEVEL FLIGHT AND CLIMB
3. SOLID SYMBOLS INDICATE DATA OBTAINED IN A CLIMB
4. 100% Ng IS 38,180 RPM



Engine Inlet Characteristics



ENGINE INLET CHARACTERISTICS

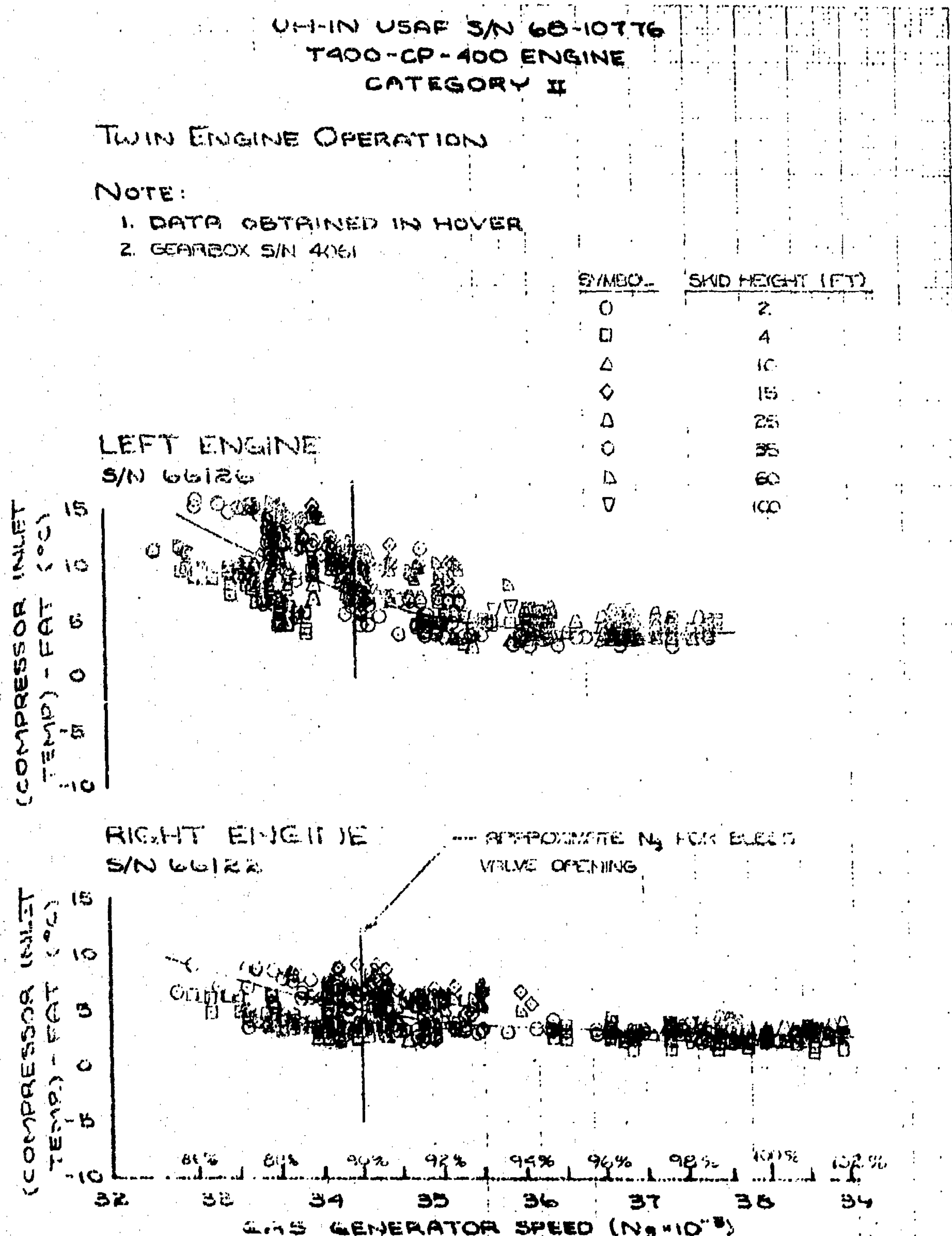


FIGURE 15C ENGINE INLET CHARACTERISTICS

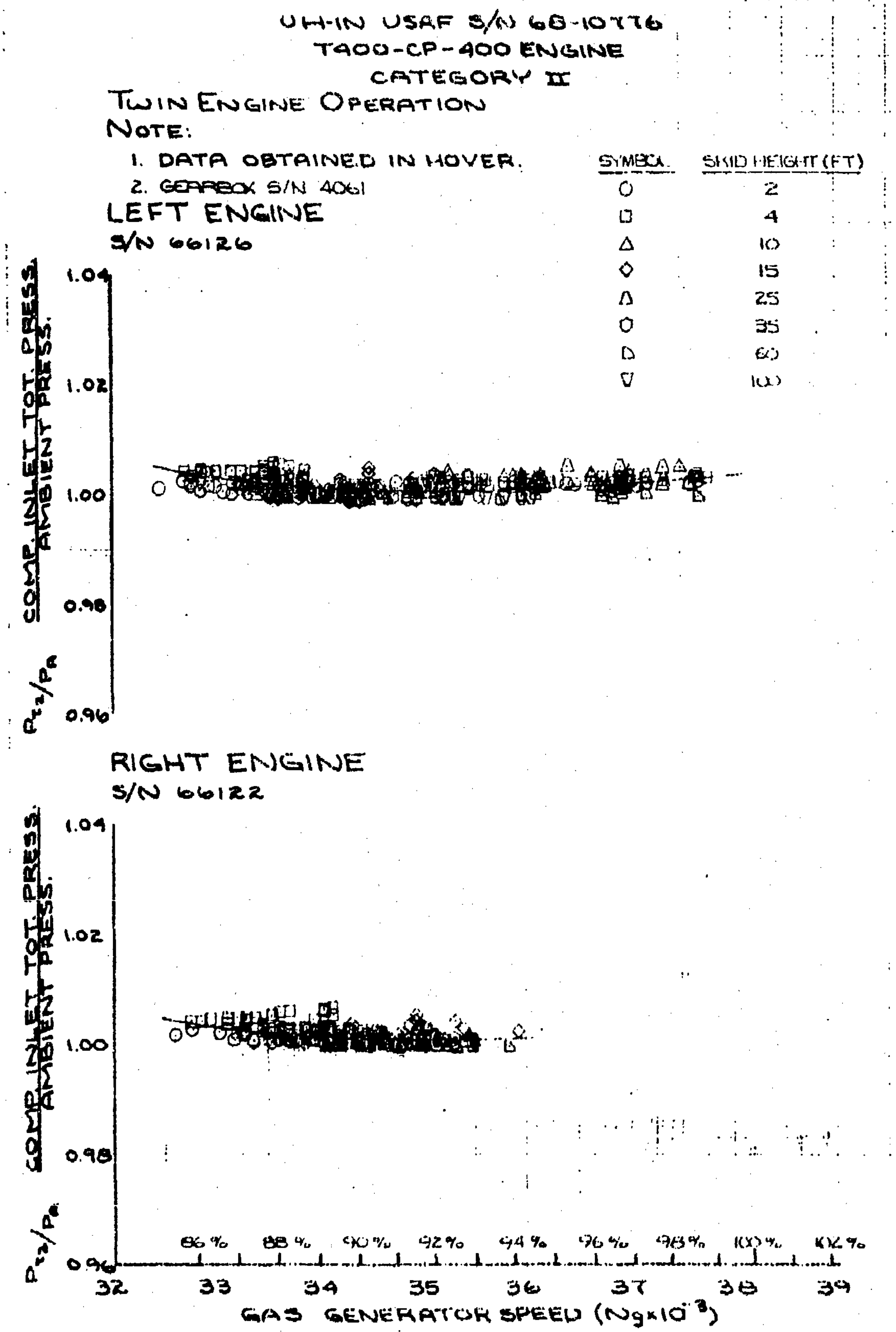
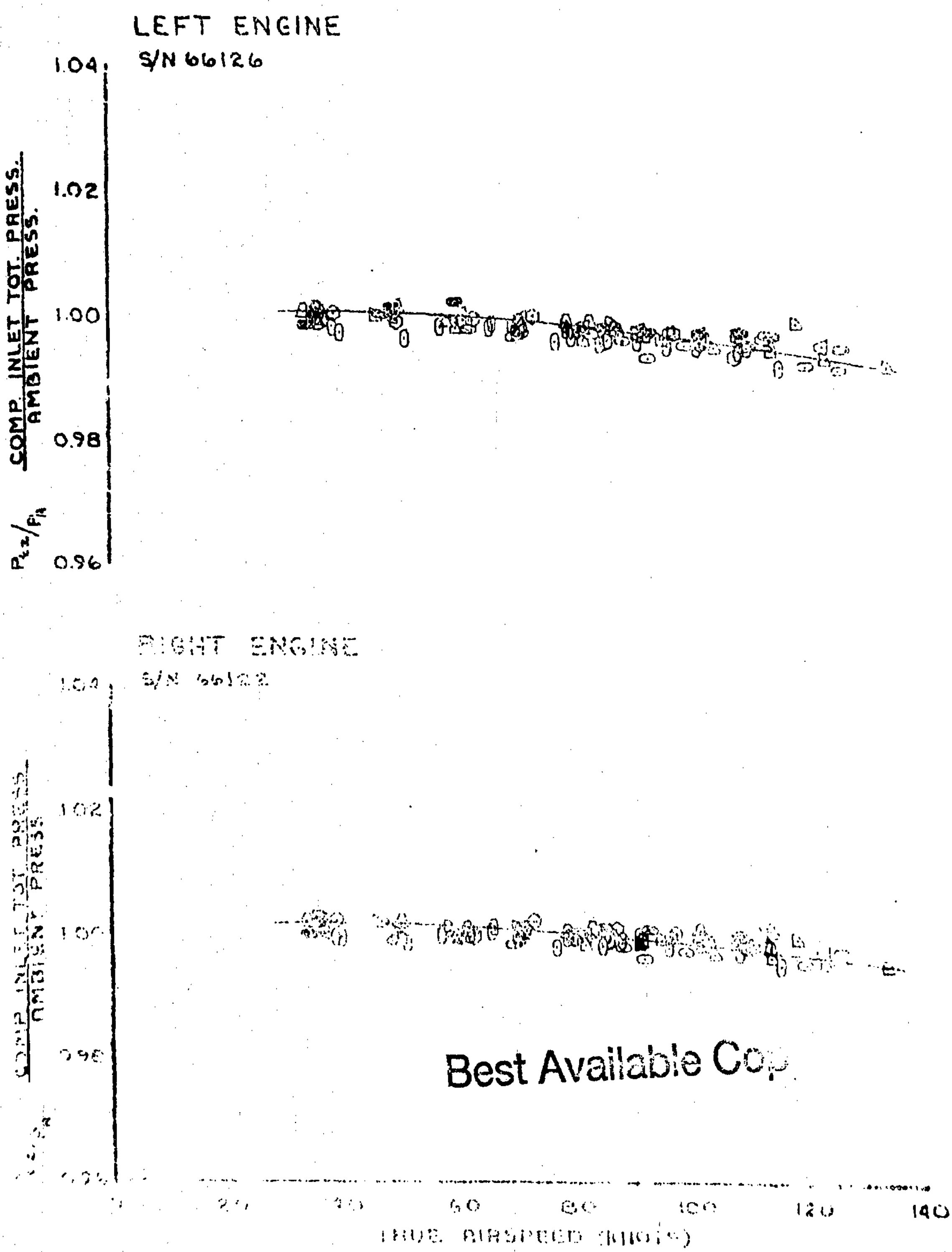


FIGURE 157 ENGINE INLET CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

TWIN ENGINE OPERATION

NOTES:
1. GEARBOX S/N [illegible]
2. DATA OBTAINED IN LEVEL FLIGHT



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INLET CHARACTERISTICS

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II
TWIN ENGINE OPERATION

NOTES:
1. GEARBOX S/N 4061
2. DATA OBTAINED IN LEVEL FLIGHT

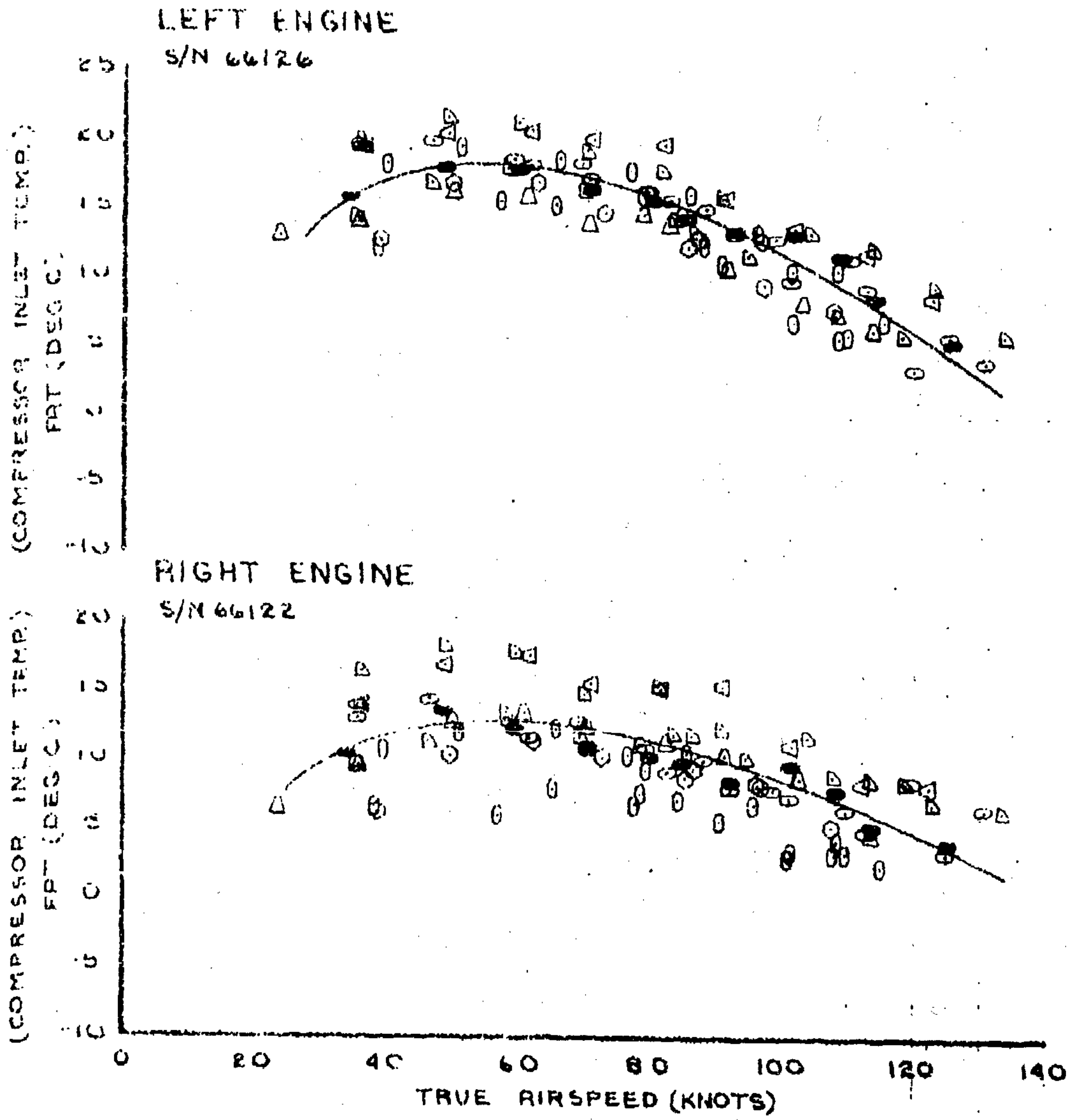

FIGURE 154 ENGINE INLET CHARACTERISTICS

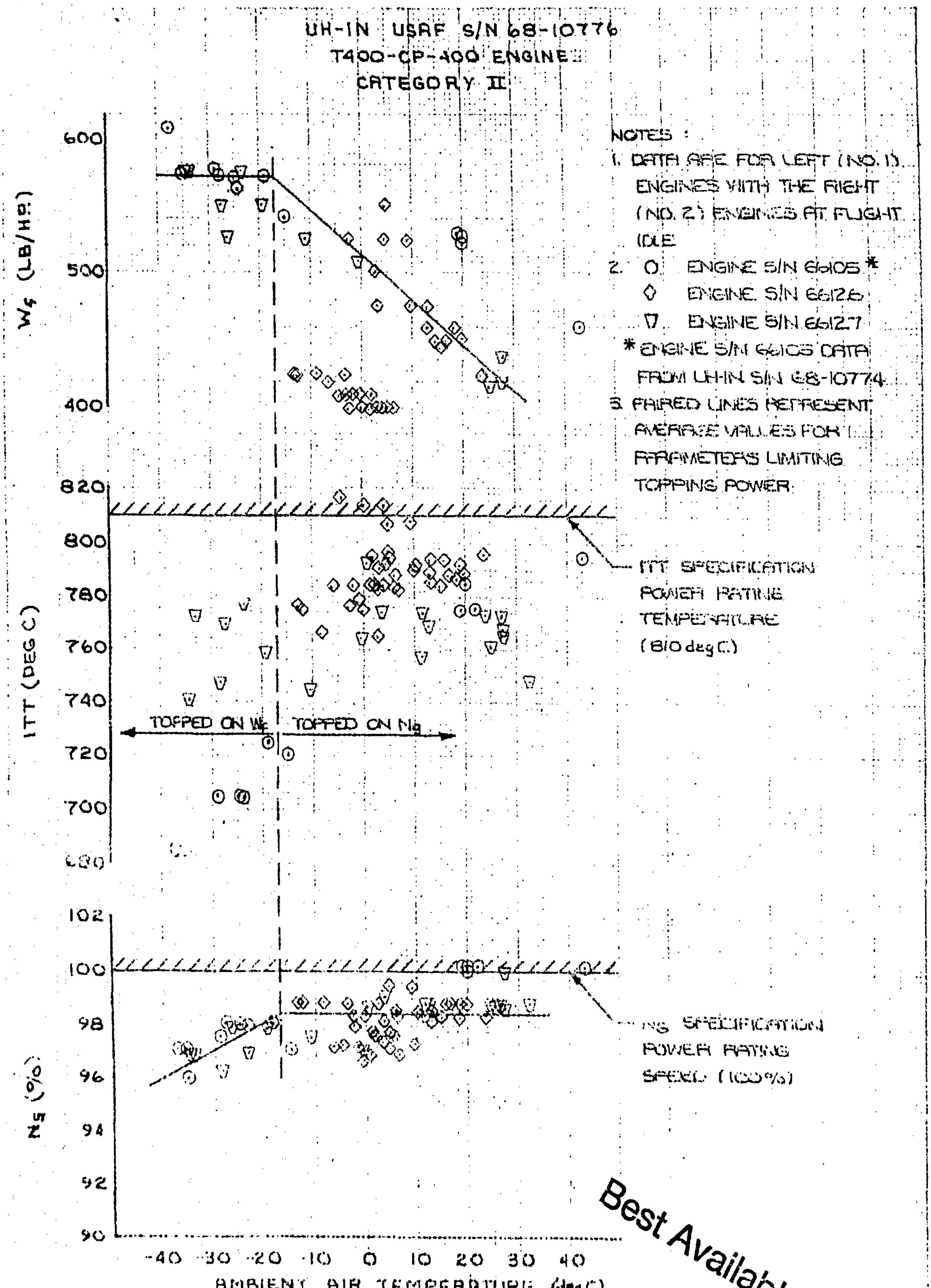

FIGURE 105 ENGINE TOPPING VARIANCE WITH Ta

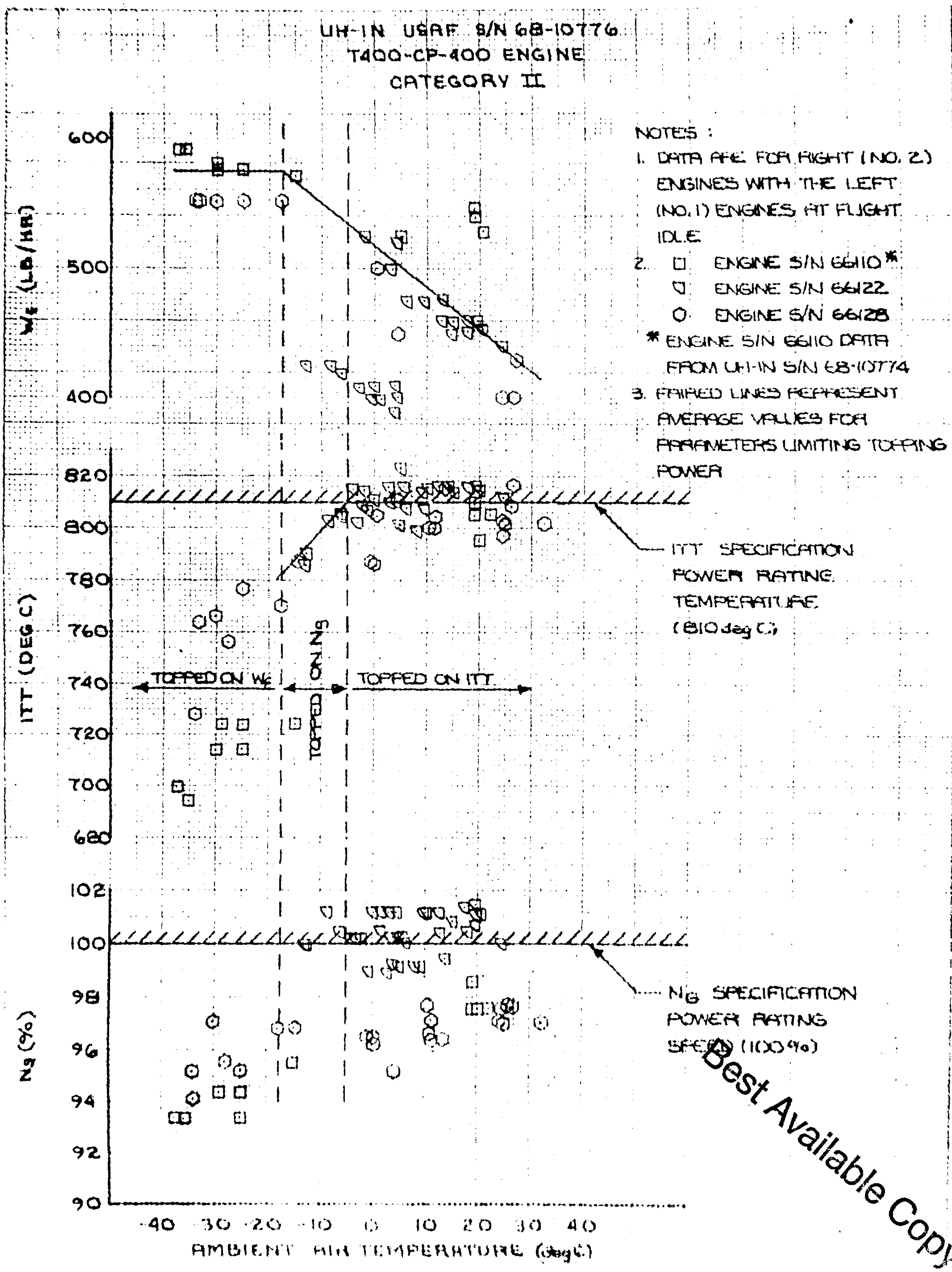

 FIGURE 161 ENGINE TOPPING VARIANCE WITH Ta.

UH-IN USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

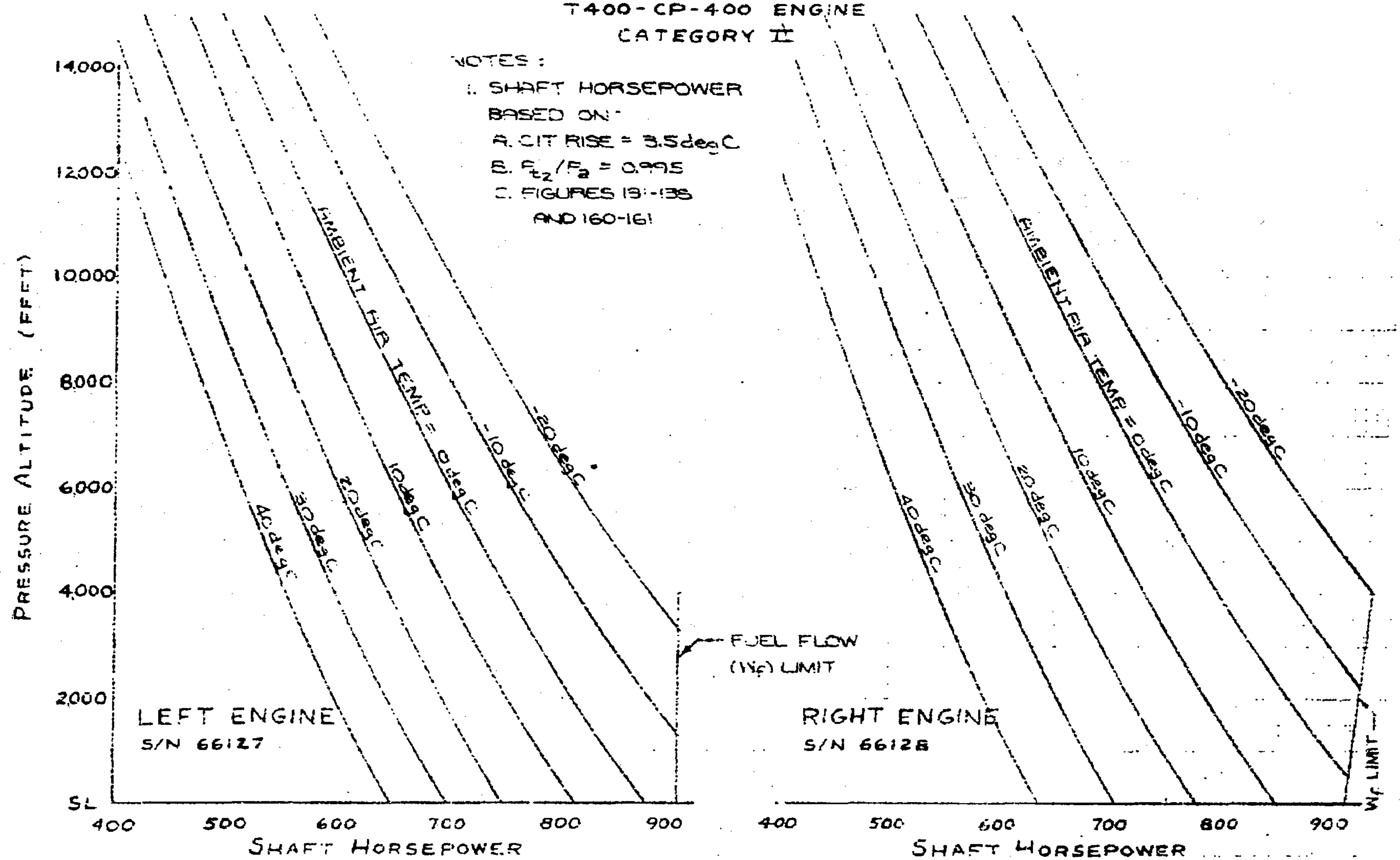

FIGURE 162 SINGLE ENGINE SHAFT HORSEPOWER AVAILABLE

UH-IN USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

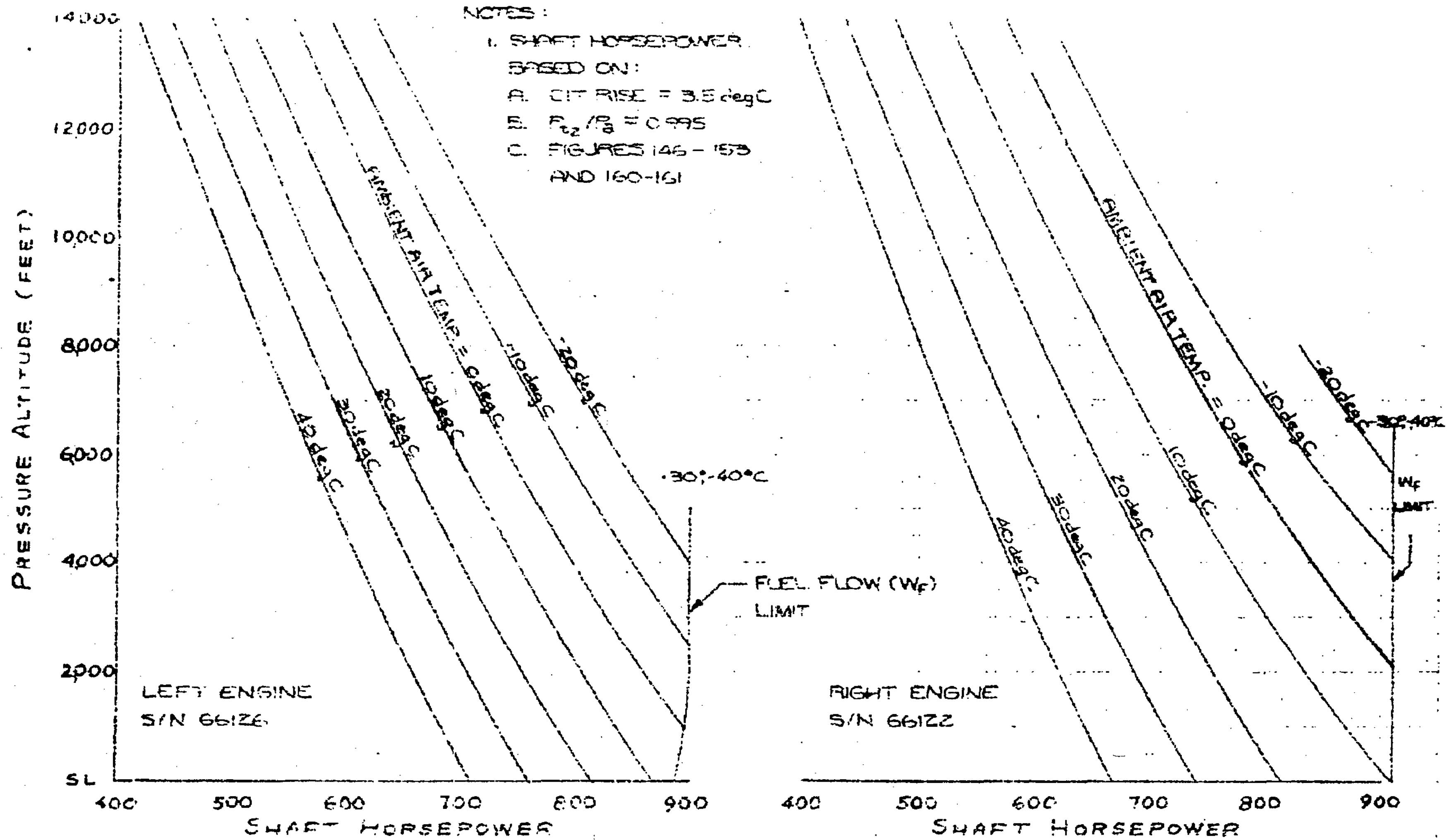

FIGURE 163 SINGLE ENGINE SHAFT HORSEPOWER AVAILABLE

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

NOTE:

1. DATA ARE FOR LEFT ENGINE (NO 1) S/N 66275 WITH RIGHT ENGINE AT FLIGHT IDLE

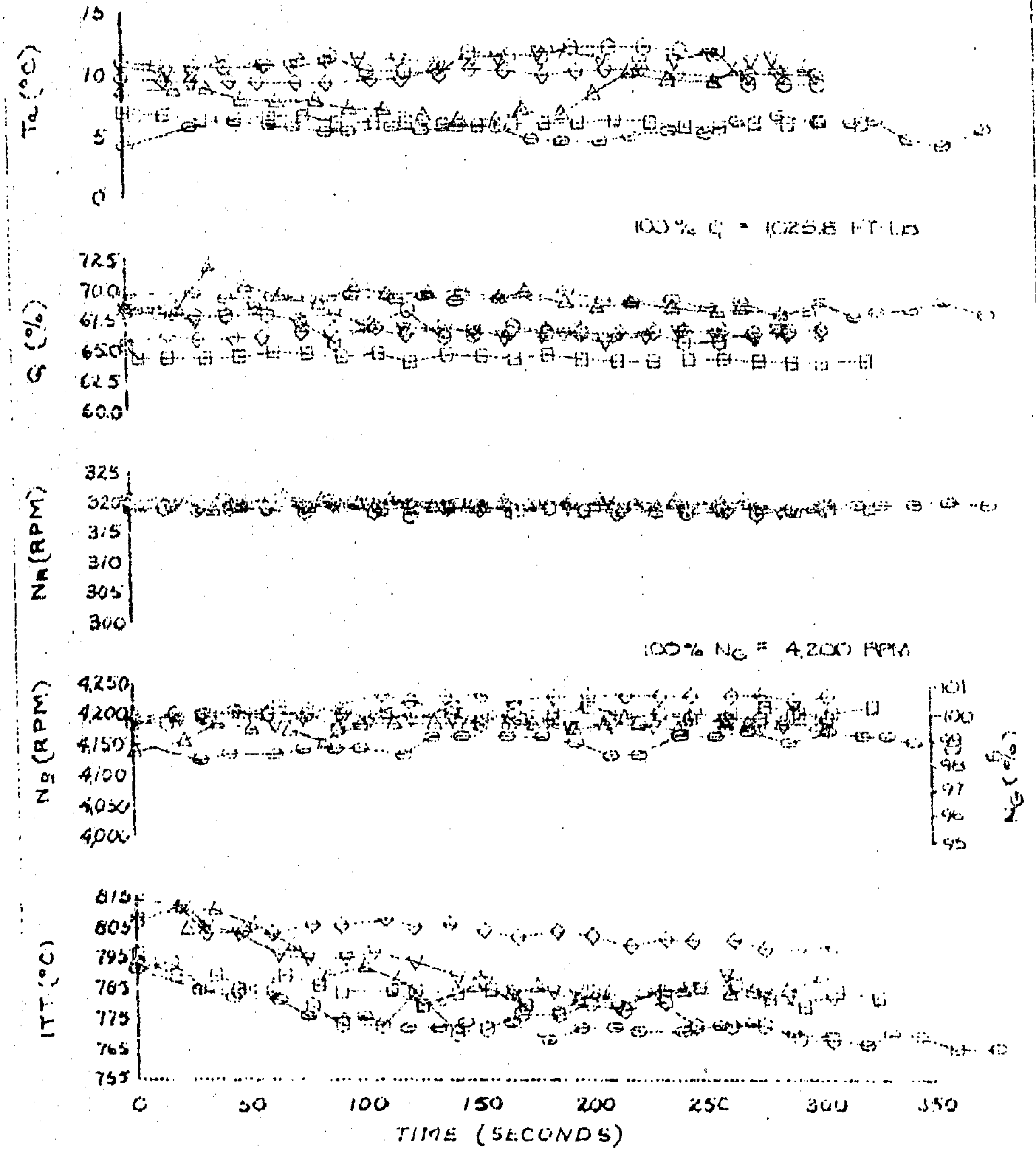

FIGURE 83 TIME HISTORY OF ENGINE TOPPING

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

NOTES :
1. DATA ARE FOR RIGHT ENGINE (NO. 2) S/N 66122 WITH THE LEFT ENGINE AT FLIGHT IDLE

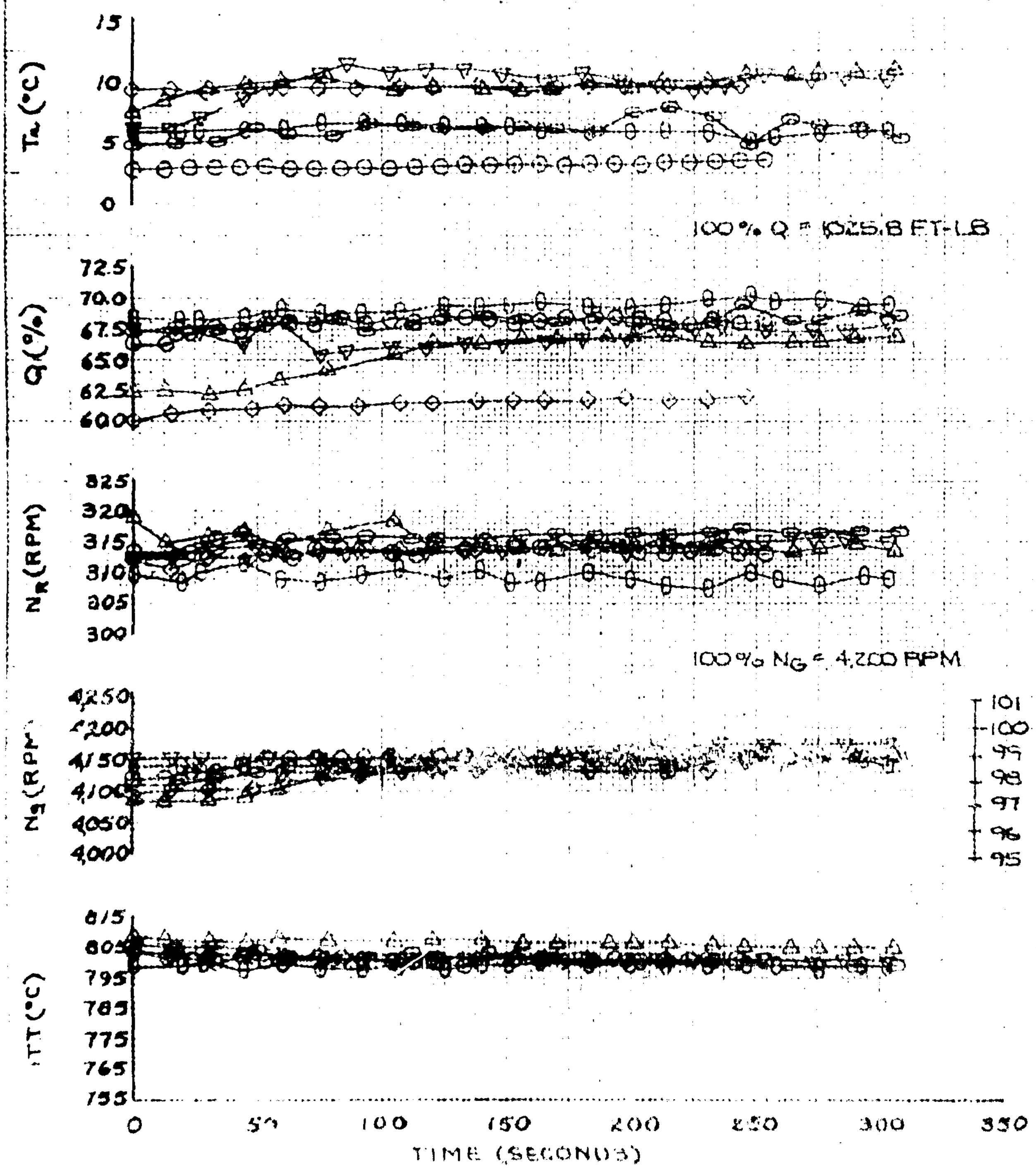

FIGURE . TIME HISTORY OF ENGINE TOPPING

UH-1N USAF S/N 68-10776
T400-CP-400 ENGINE
CATEGORY II

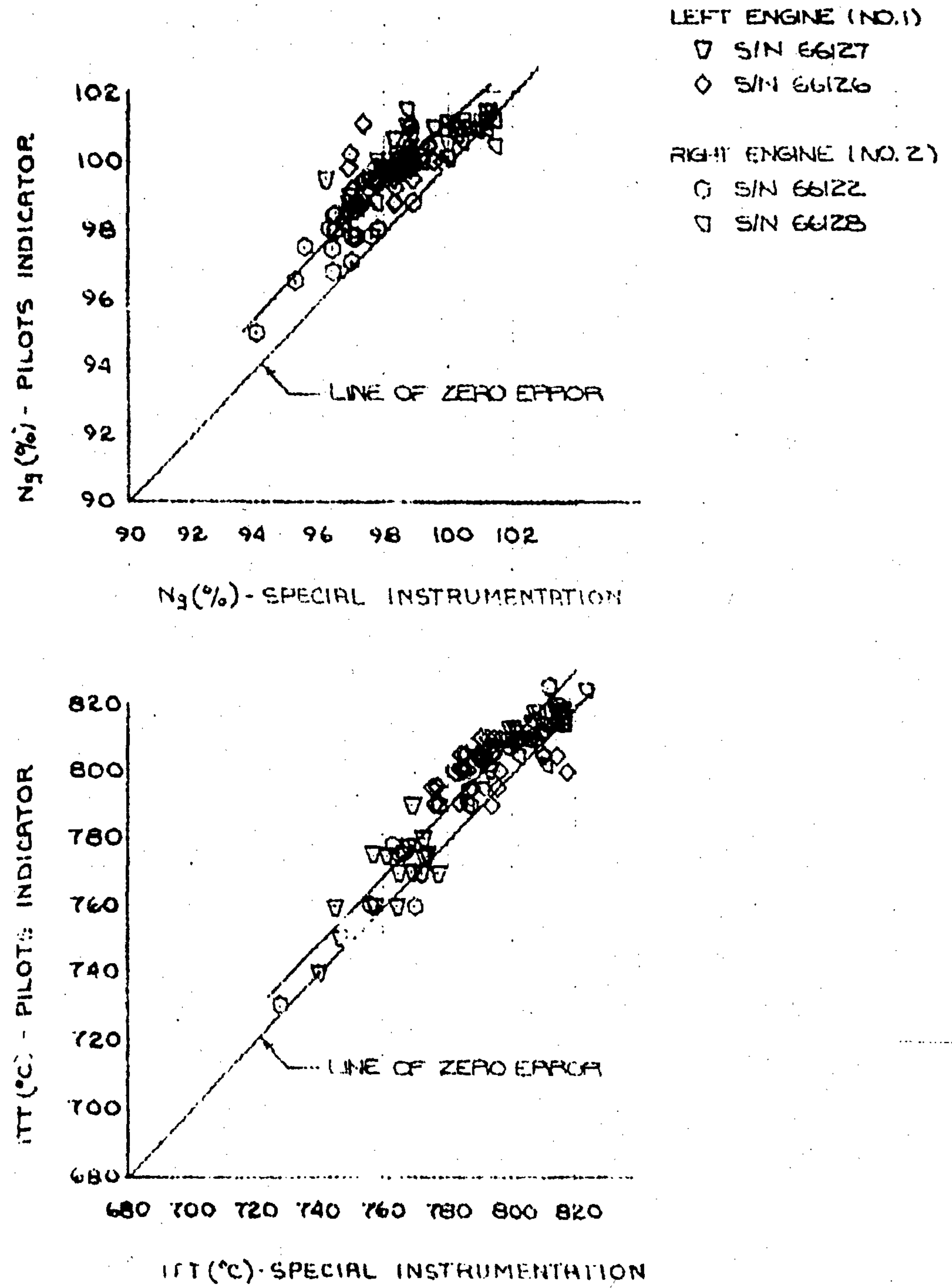

FIGURE 67. COMPARISON OF PILOT PANEL AND SPECIAL INSTRUMENTATION READINGS FOR ITT AND Ng

APPENDIX II
GENERAL AIRCRAFT INFORMATION

Dimensions and Design Data

Overall Dimensions

Aircraft length (rotors turning)	57 ft 0.7 in.
Height (to top of turning tail rotor)	14 ft 4.7 in.
Height (to top of rotor crown)	13 ft 1.0 in.
Aircraft width (rotors stopped)	9 ft 4.0 in.
Skid width	8 ft 8.4 in.

Main Rotor

Number of blades	2
Rotor diameter	48 ft
Rotor disc area (A)	1809.0 sq ft
Blade chord	23.375 in.
Blade airfoil	
Blade root to 80-percent radius	NACA 0012 (modified)
Blade tip (linear taper from 80-percent radius)	NACA 0006 (modified)
Geometric solidity ratio	0.05167
Main rotor clearance, ground to top (rotor static against stops)	7 ft 2 in.
Forward tilt of rotor shaft	5 deg

Main Rotor Blades

Pitch, collective (measured at the 75-percent radius station)	0 to +15 deg
Pitch, cyclic (measured at hub yoke)	
Longitudinal	±12 deg
Lateral	±10 deg
Flapping	±11 deg
Preconing angle	2.75 deg
Blade twist (total)	-10 deg

Tail Rotor

Number of blades	2
Diameter	8 ft 6 in.
Solidity ratio	0.1436

Tail Rotor Blades

Blade chord (constant)	11.5 in.
Blade twist	0 deg
Hub precone angle	1.5 deg
Airfoil section	NACA 0018 at sta 12.75 tapering to NACA 0008.27 at sta 51.0
Aspect ratio	8.9
Range of flapping	±8 deg

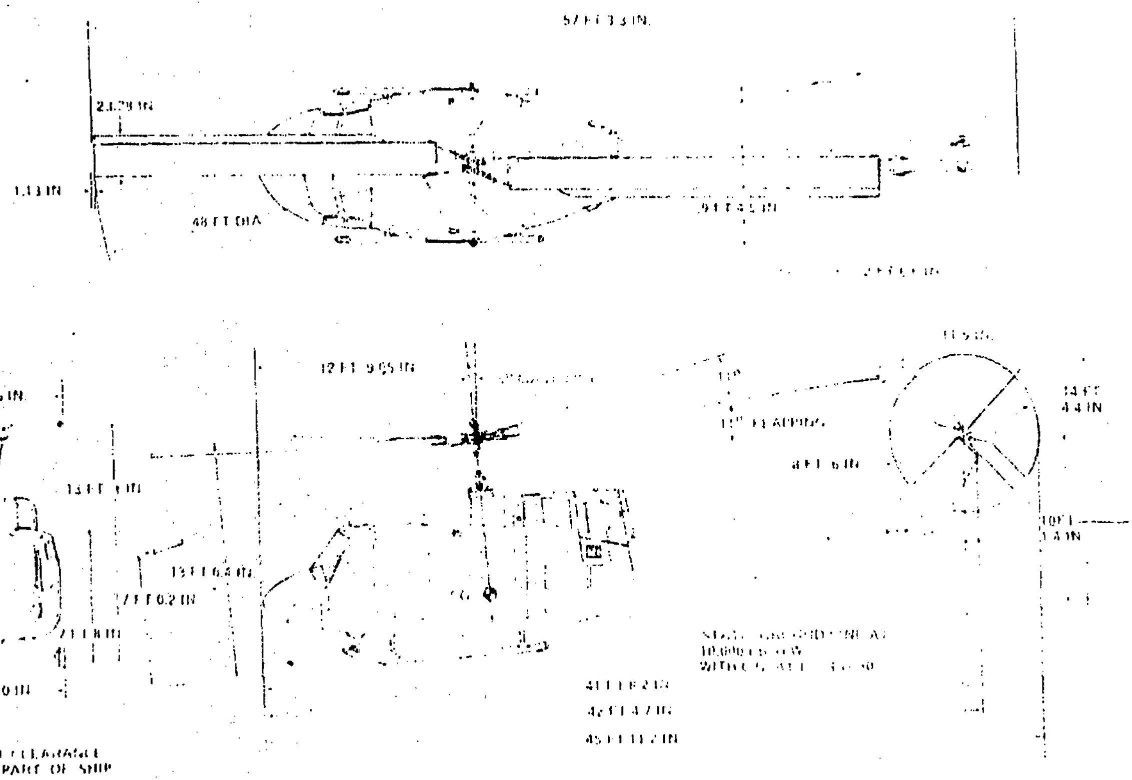

Figure 1 Principal UH-1N Dimensions

Main Rotor Speeds

Power-on design maximum	324 rpm
Power-on design minimum	294 rpm
Power-off design maximum	339 rpm
Power-off design minimum	294 rpm
Power-on or-off limit	356 rpm

Gear Ratios

Engine power turbine speed to engine output shaft speed	5:1
Main rotor transmission (engine output shaft speed) to main rotor speed	20.37:1
90-degree gearbox	2.59:1
Intermediate gearbox	1:1
Engine output shaft speed to tail rotor speed	3.98:1
Tail rotor speed to main rotor speed	5.122:1

Limit Flight Load Factors

At 6,600 lb (basic design gross weight)

Maneuver loads (g's)	
Positive	3.5
Negative	-0.5

At 10,000 lb (alternate mission gross weight)

Maneuver loads (g's)	
Positive	2.3
Negative	0.33

Design Maximum Speed

Level flight	130 KIAS
Sideward flight	35 KIAS
Rearward flight	30 KIAS

Main Transmission Rating

At 6,400 rpm output shaft speed

Takeoff (5-minute)	1,250 shp
Normal (continuous)	1,100 shp

Weights

Design gross weight	6,600 lb
Maximum gross weight (internal)	10,000 lb
Fuel capacity (design)	212.5 gal (1,381 lb of JP-4 at 6.5 lb/gal)
Empty gross weight	6,000 lb

Control Riggings

Collective control full down - Main rotor blade pitch angle at blade root	7.0 deg
Collective control full up - Main rotor blade pitch angle at blade root	21.0 deg
Right pedal full forward - Tail rotor blade pitch angle at blade root	-10.4 deg
Left pedal full forward - Tail rotor blade pitch angle at blade root	21.9 deg

Rotor Systems

The main rotor is a two-bladed, semi-rigid, teetering type employing preconing and underslinging. Each blade is connected to a common yoke by a grip and pitch-change bearings with tension straps to carry centrifugal loads. Teetering motion of the rotor takes place about an axis perpendicular to the spanwise axis of the rotor. A stabilizer bar is provided to improve the inherent stability characteristics of the rotor.

Main rotor blades are "thin tip" blades; the basic NACA 0012 airfoil was modified by introducing a linear taper in thickness from a 12-percent airfoil section at the 80-percent blade radius station to an NACA 0006 airfoil section at the blade tip, and by then attaching a 2-3/8-inch chordwise extension to the blade trailing edge. The extension increases the blade chord length to a constant value along the span of 23-3/8 inches.

The two-bladed tractor tail rotor is a rigid, delta-hinged type employing preconing and underslinging. Each blade is connected to a common yoke by a grip and pitch-change bearing; the blade and yoke assembly is attached to the tail rotor shaft by a delta-hinge trunnion to minimize flapping. Tail rotor blades are also of the "thin tip" design, but without the chordwise trailing edge extension.

Rotor control systems are boosted by two irreversible and completely independent hydraulic boost systems. System 1 supplies boost pressure to the cyclic, directional, and collective controls; system 2 supplies boost pressure to the cyclic and collective controls only. Pressure, supplied by two transmission-driven pumps, is admitted to the appropriate boost cylinder through a power cylinder servo valve actuated by movement of the cockpit controls. A force trim system and an artificial force gradient or "feel" are provided for the cyclic and directional controls through a system of magnetic brakes and springs.

Power Plant

The aircraft is powered by a United Aircraft of Canada Limited T400-CP-400 power package consisting of two PT6T free-turbine turboshaft engines, each with an uninstalled rating of 900 shaft horsepower at sea level, standard day conditions. The power sections are coupled to a combining gearbox which has a single output shaft to drive the uprated (1,250 shaft horsepower) main transmission. Overrunning clutches in the drives of the two power sections permit torque to be transmitted in one direction only, providing for single-engine operation and two-engine-out autorotation. An automatic torque matching unit provides for balanced load sharing between the two power sections. The torque matching unit receives oil pressure signals from each power section proportional to the torque output of that engine. Equalization of engine output torques is achieved by comparing the two torque pressures and sending an "increase fuel flow" signal to the automatic fuel control unit of the relatively low-torque-output power section.

The engine combining gearbox has a hydromechanical torquemeter installed as an integral part of the reduction gearing. Figure 2, appendix II, presents the torquemeter operation. The operation of the torquemeter is based on the principle that a torque applied to a helical gear produces an axial force normal to the gear's plane of rotation. The output torque of each engine is transmitted through a helical gear to that engine's torquemeter. The torquemeter senses torque through a helical gear attached to a piston. Torque applied to the gear causes an axial displacement of the piston which, in turn, opens a port allowing oil under pressure to pass through the hollow shaft of the piston to a cavity adjacent to the piston face. Oil pressure against the piston face increases until the axial force caused by the engine torque is neutralized. The relationship between the oil pressure required to neutralize the axial force on the piston and the engine output torque passing through the combining gearbox was determined for the Category II test power sections and gearboxes via laboratory calibrations. The calibrations for power package combining gearbox S/N 4061 with power section S/N's 66121 and 66122 are presented for twin-engine operation in figure 3, appendix II, and for single-engine operation in figures 4 and 5, appendix II. The calibrations for power section S/N's 66127 and 66128 are presented in figures 6 through 8, appendix II.

For twin-engine operation, the relationship between output torque (ft-lb) and torquemeter oil pressure (psi) is independent of power turbine speed, engine oil temperature and bleed valve operation. For single-engine operation, the relationship between output torque and torquemeter oil pressure is independent of power turbine speed and the operating mode of the second power section (flight idle or shut down).

Weight and Balance

The basic weight of the test aircraft, measured with full oil, trapped fuel and test instrumentation installed was 6,733 pounds. The cg location for this configuration was at fuselage station 144.44.

Flight Limits

Center of gravity limits and airspeed limits were obtained from reference 2 and are presented in appendix II, figures 9 and 10, respectively.

Test Instrumentation

Test instrumentation supplied by AFFTC was installed by Bell Helicopter Company (BHC) of Fort Worth, Texas, in accordance with AFFTC drawings. Initial calibrations were accomplished by BHC with subsequent calibrations, modifications, and maintenance being accomplished by AFFTC. The basic instrumentation package consisted of a CEC 5-119-P3-5 50-channel oscillograph, a photorecorder, a time correlation system, a "tail low" warning system, and associated sensors and wiring.

Instrumentation List

See appendix II of FTC-SD-71-50, UH-1N Category II Flying Qualities Evaluation, Air Force Flight Test Center, Edwards AFB, California, January 1972.

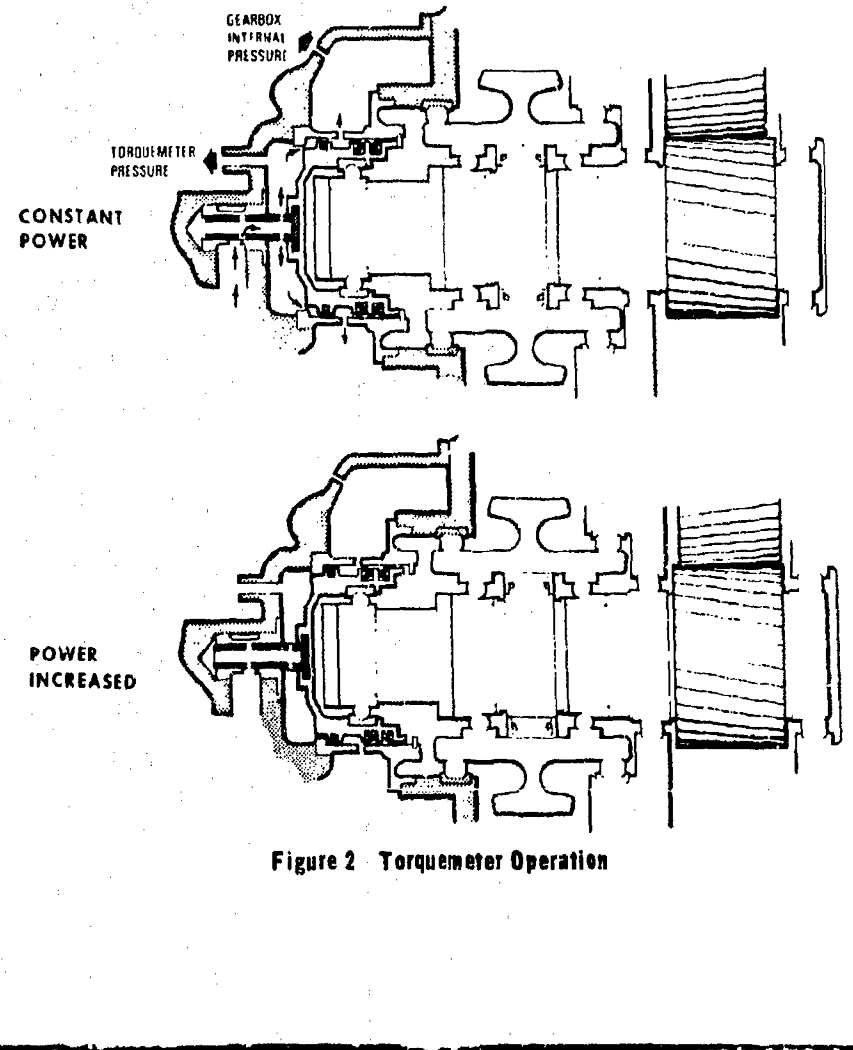

Figure 2 Torquemeter Operation

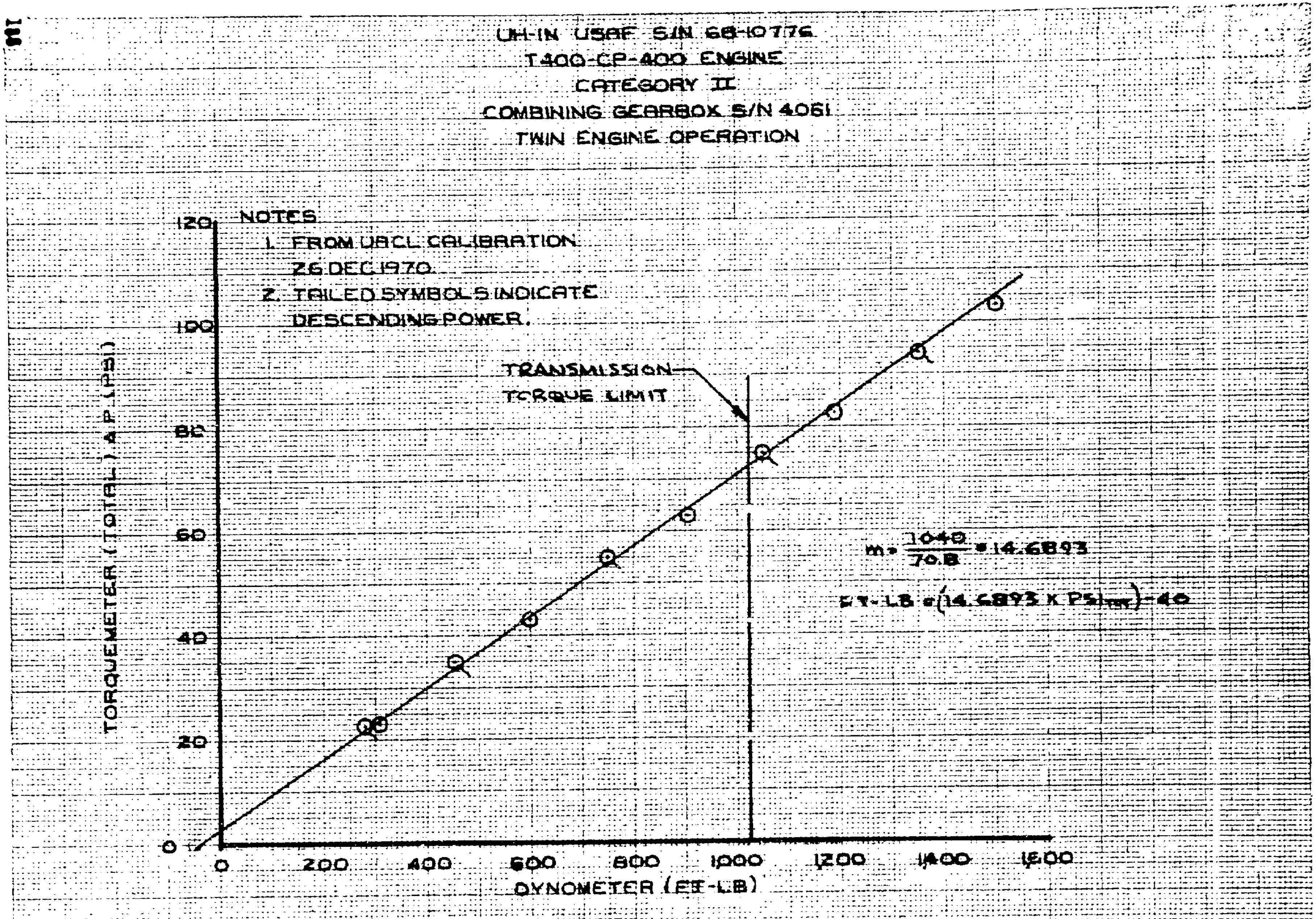

FIGURE 8 COMBINING GEARBOX TORQUEMETER CALIBRATION

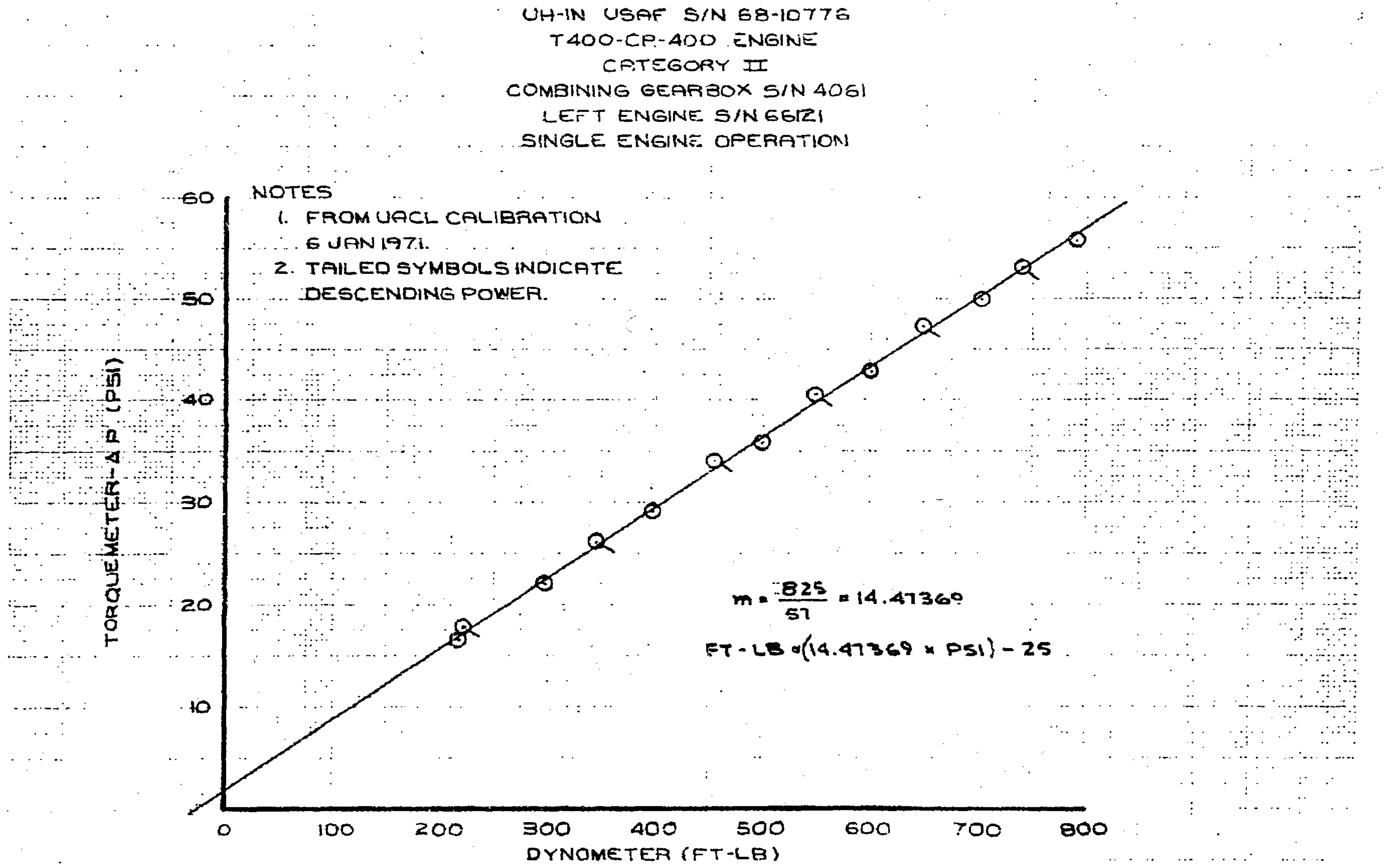

FIGURE 4 . COMBINING GEARBOX TORQUEMETER CALIBRATION

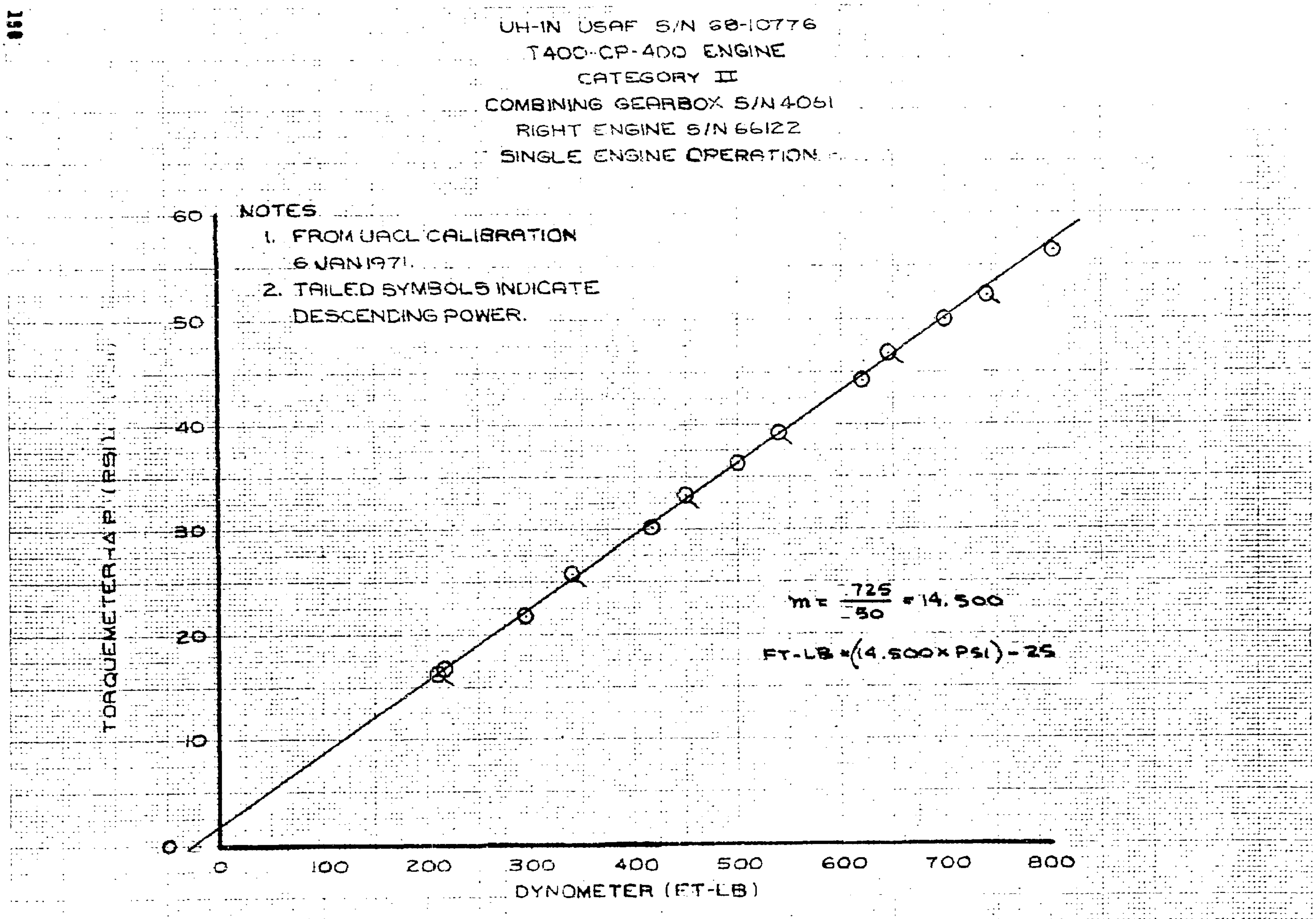

FIGURE 5 COMBINING GEARBOX TORQUEMETER CALIBRATION

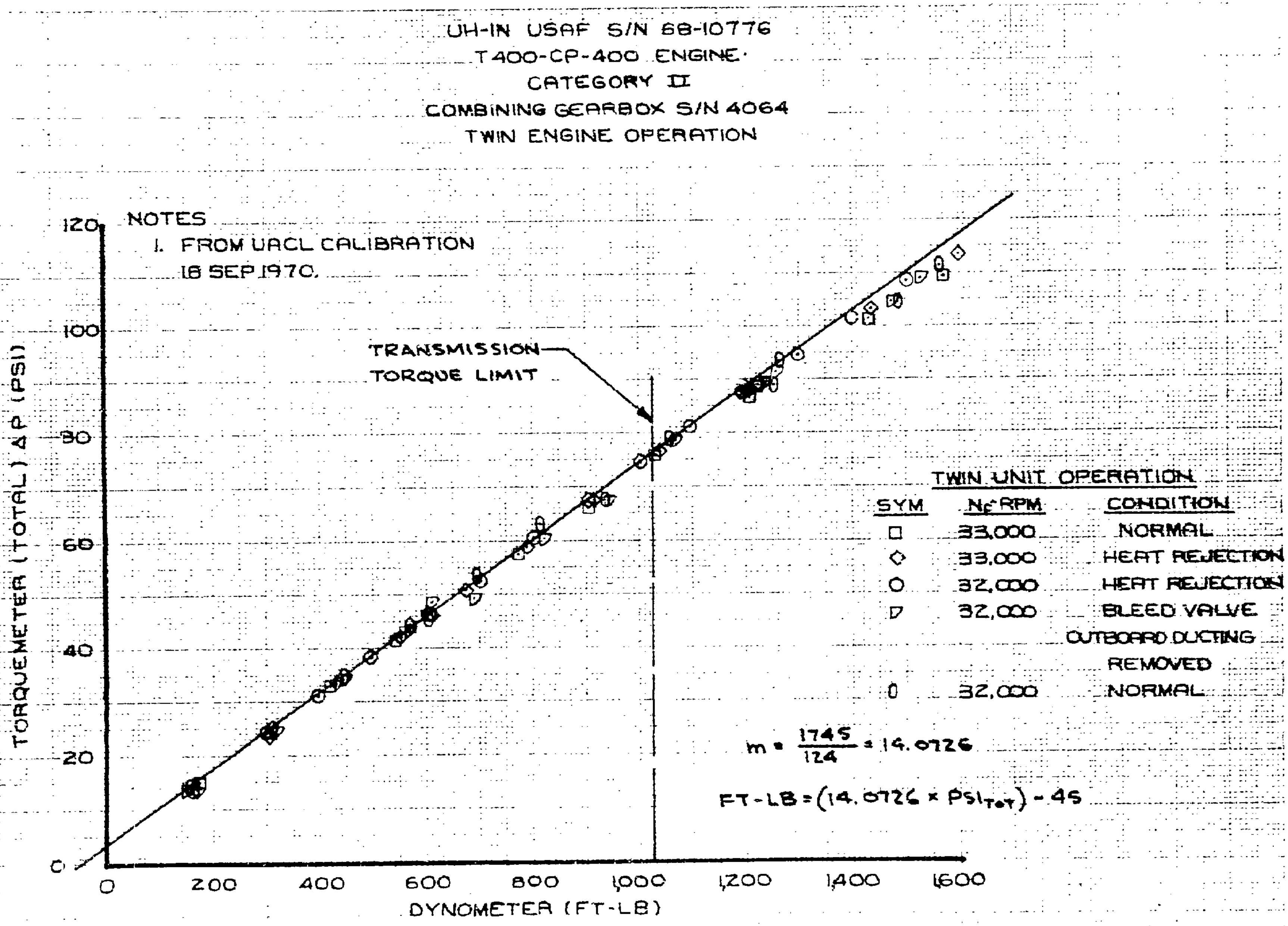

FIGURE 6 COMBINING GEARBOX TORQUEMETER CALIBRATION

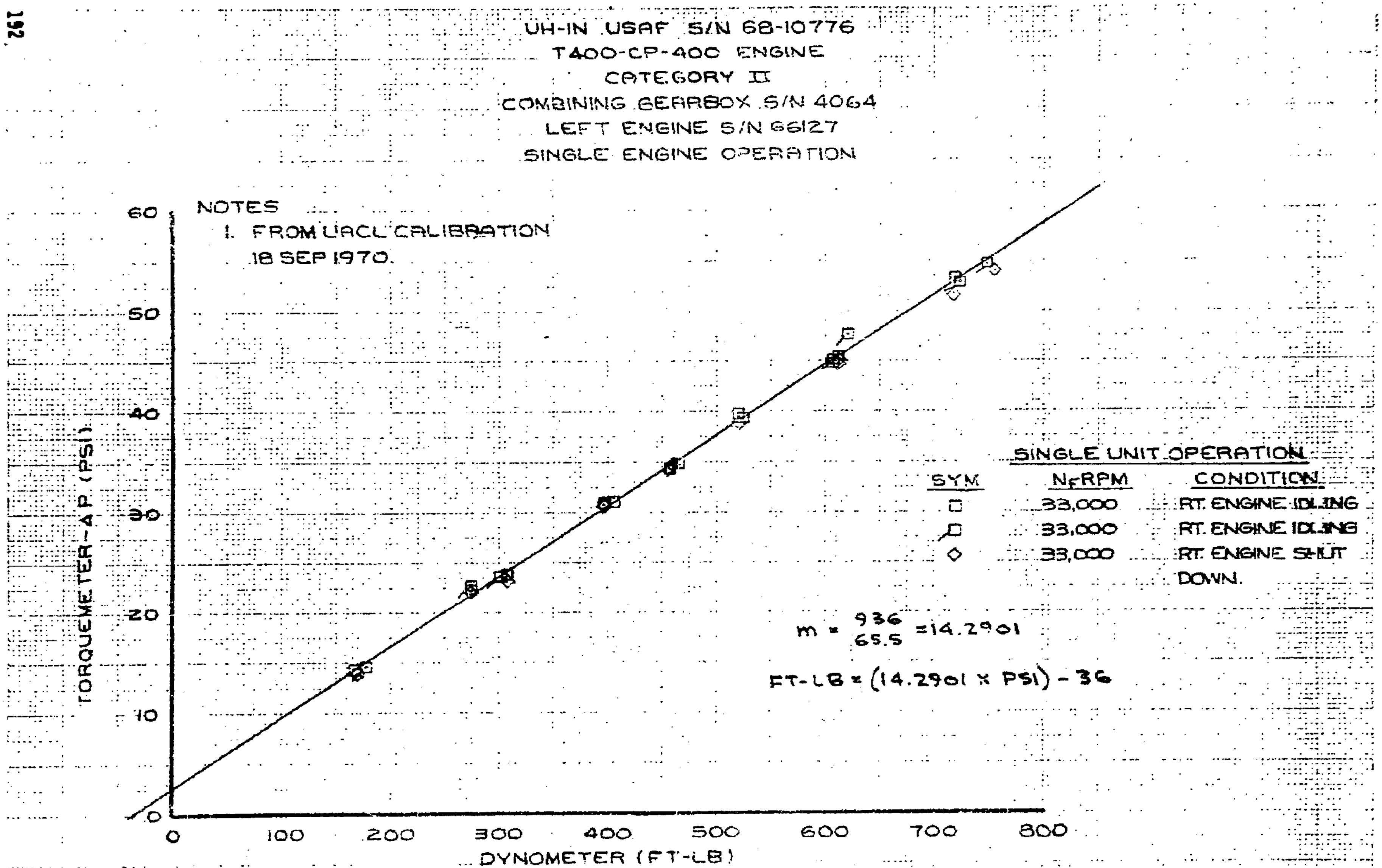

FIGURE . COMBINING GEARBOX TORQUEMETER CALIBRATION

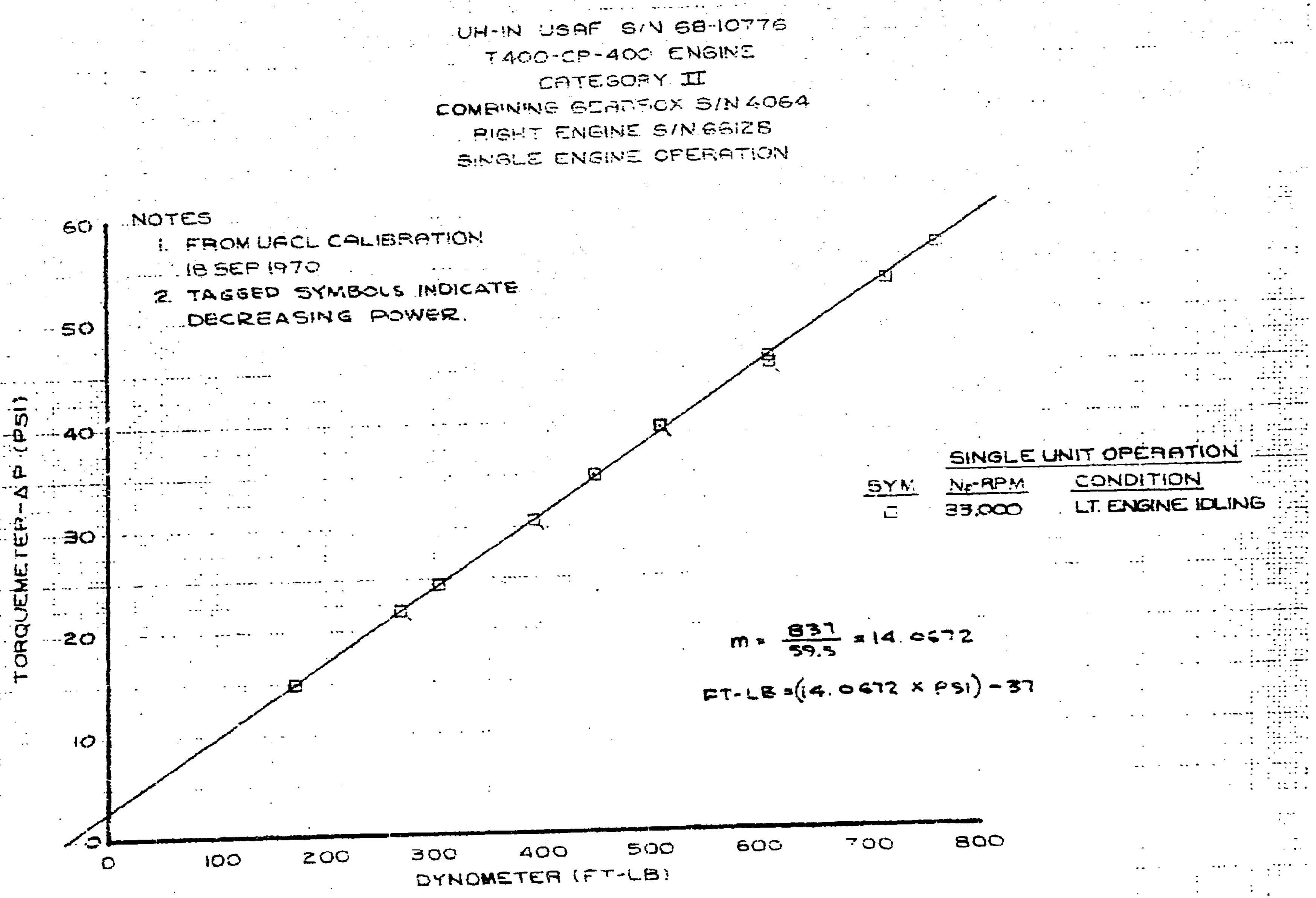

FIGURE 8 COMBINING GEARBOX TORQUEMETER CALIBRATION

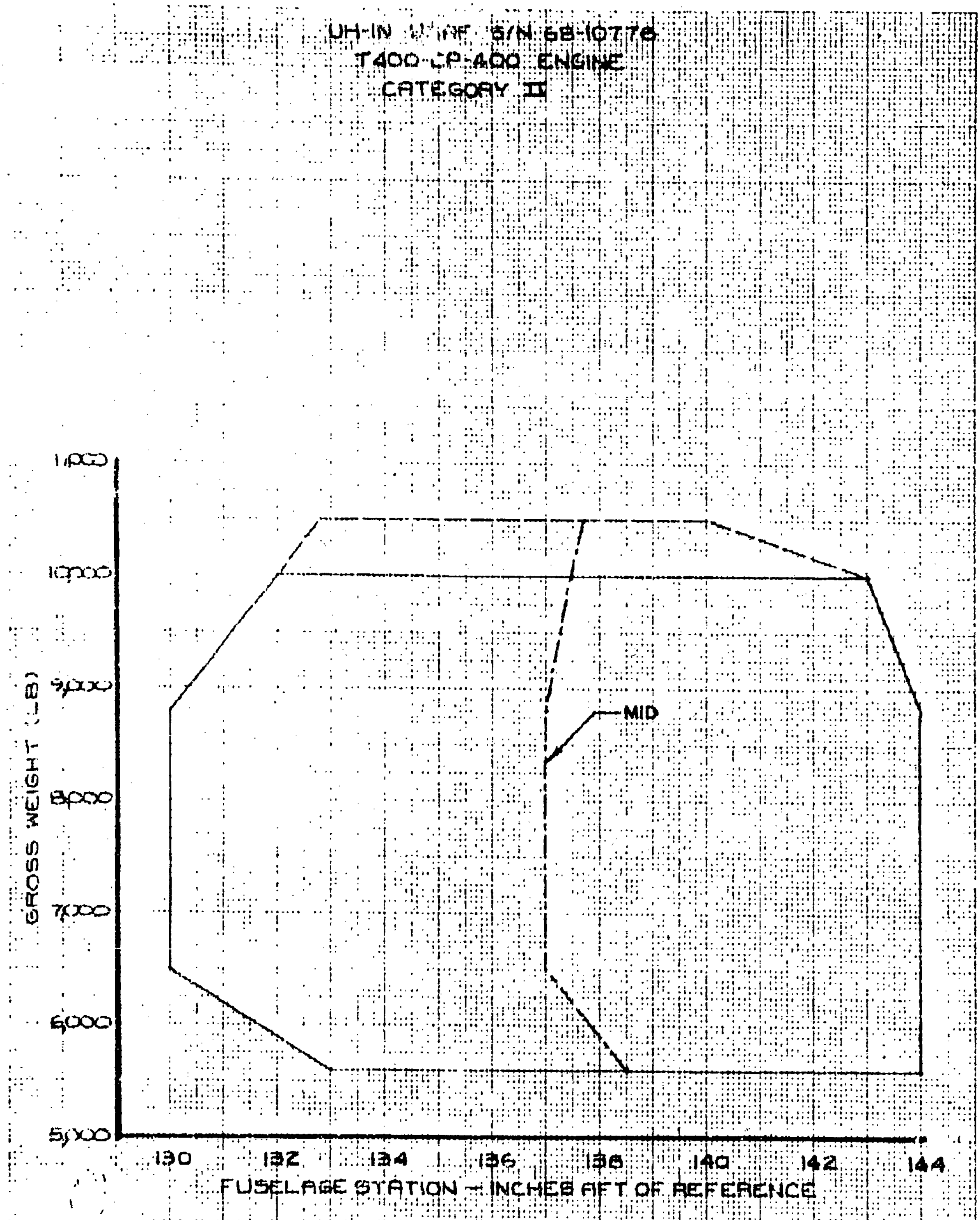

 FIGURE 9 LONGITUDINAL CENTER OF GRAVITY LIMIT ENVELOPE

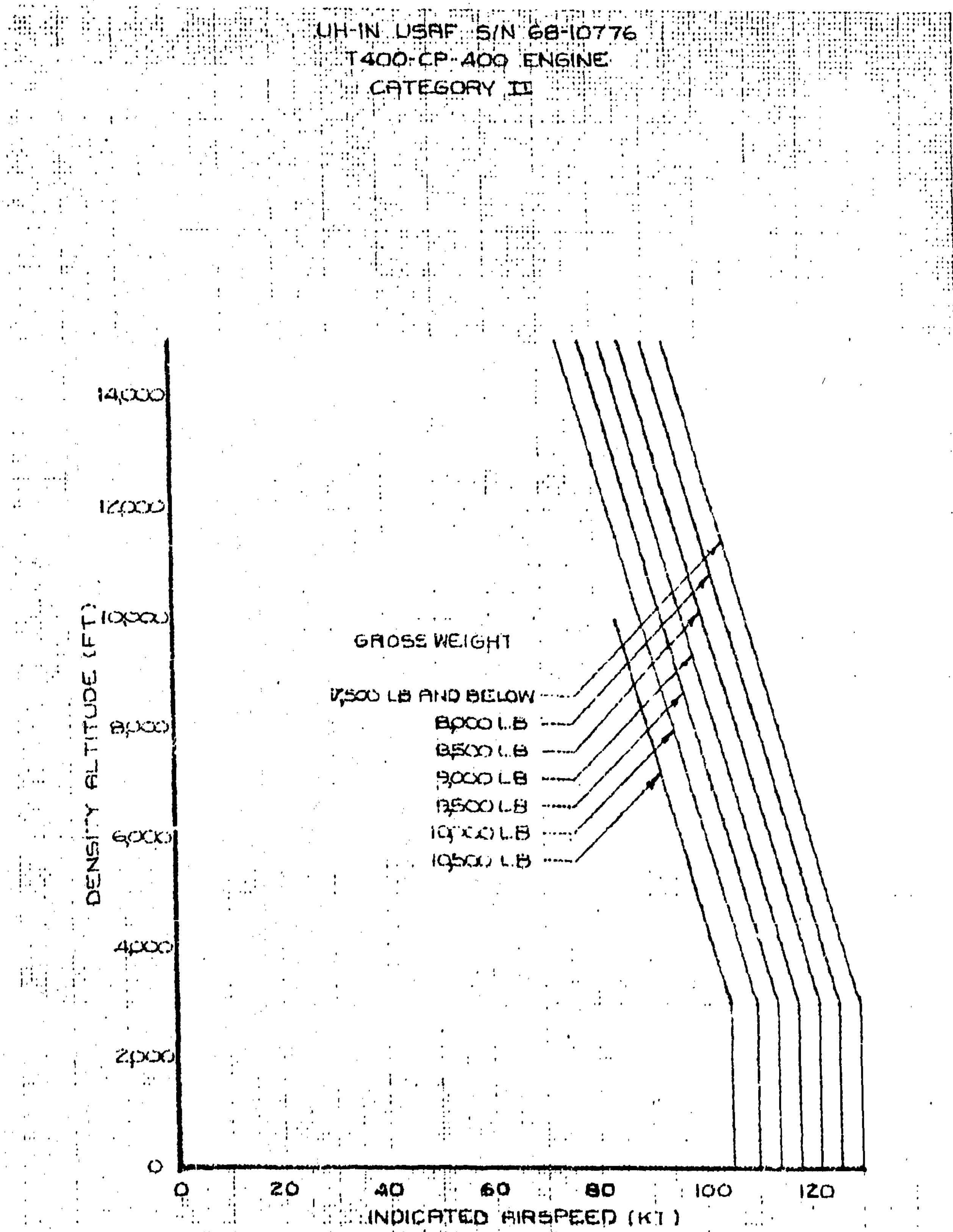

FIGURE 10 AIRSPEED LIMIT ENVELOPE

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Security Classification

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11. SUPPLEMENTARY NOTES This is Volume II of II.	12. SPONSORING MILITARY ACTIVITY 6510th Test Wing Edwards AFB, California

13. ABSTRACT

This volume presents the test techniques, data analysis methods, test data, and general aircraft information for the Category II performance evaluation of the UH-1N helicopter.

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	ROLE	WT	ROLE	WT	ROLE	WT
UH-1N helicopter performance test techniques test data data analysis aircraft description						

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